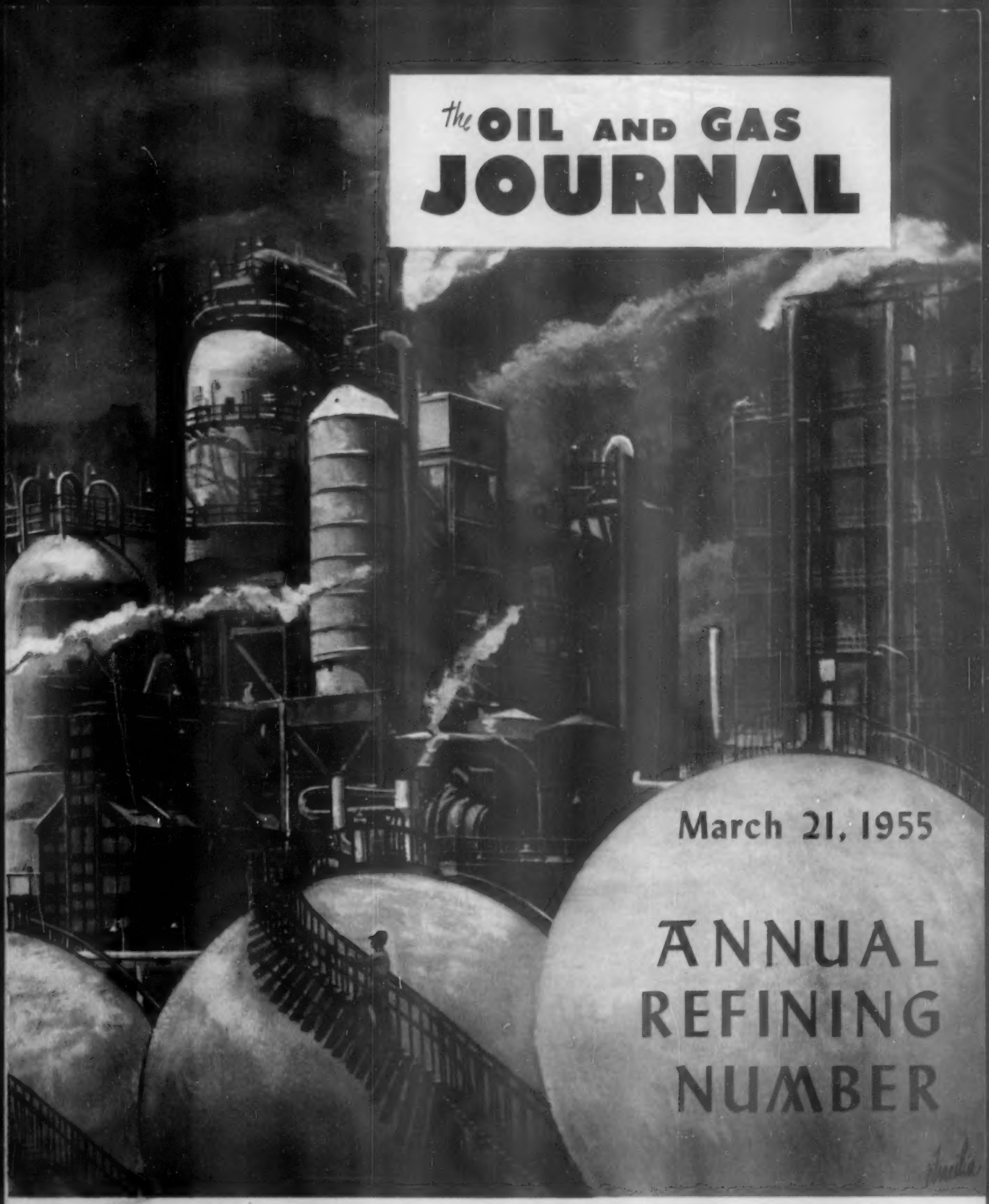

the OIL AND GAS JOURNAL

March 21, 1955

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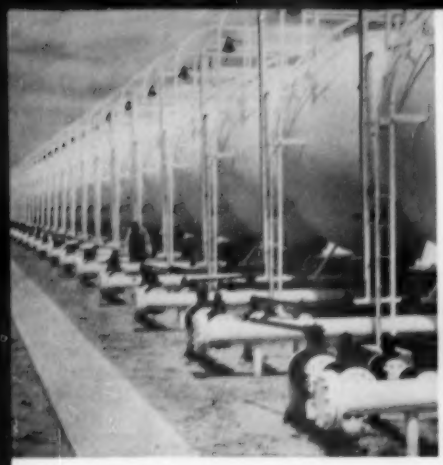
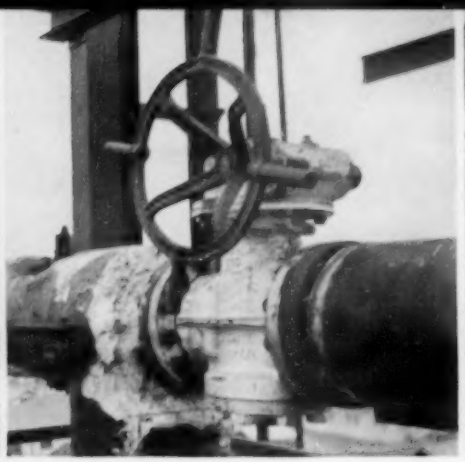

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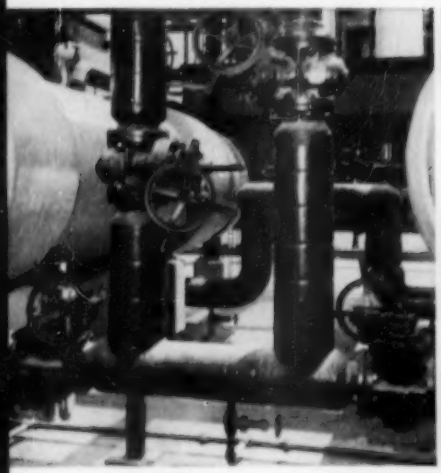
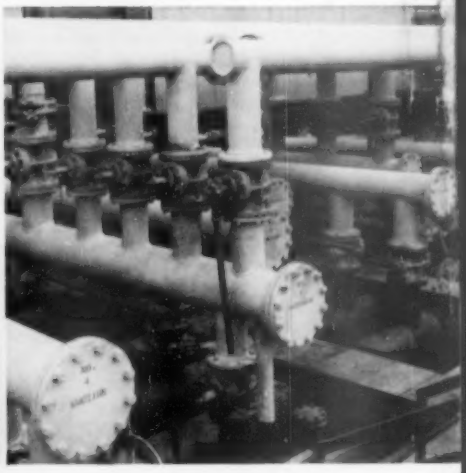
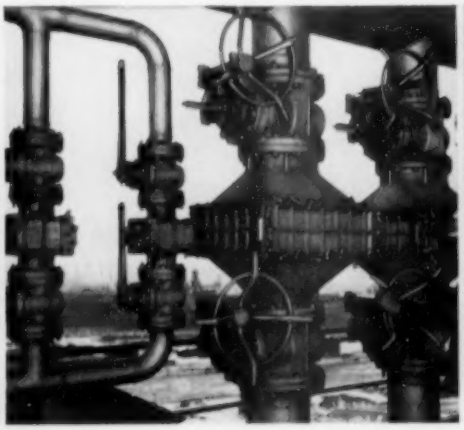
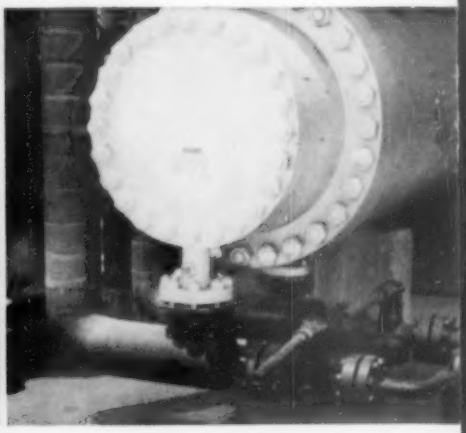




costs less per year when you specify

ROCKWELL-Nordstrom VALVES

LUBRICANT SEALED FOR POSITIVE SHUT-OFF

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee Peacock Brothers Limited

PAGE 1 ONE . . . *a glance ahead*

New oil legislation in Guatemala seems remote. A recent decree authorized preliminary exploration, but full-fledged law which would attract investments by U. S. oil companies is still in the discussion stage.

New cracking catalysts, both fluid and pelleted, will be introduced during next few months. Research on catalysts is being intensified, and results of some projects are due for early announcement. Some price reductions may be in the cards.

Oil companies buying Government rubber plants won't go into tire or other finished products business, remaining content to sell raw materials to fabricators. But they will enter a research race to develop better and cheaper rubber components and particularly new petrochemicals allied with the rubber processes.

Fast and favorable action by FPC is expected by Westcoast Transmission, Pacific Northwest Pipeline, and El Paso Natural Gas on three-way deal announced in December, to be formally filed within few days. Reports of major changes in routings are unfounded, confused with nebulous plans for future supplemental lines in British Columbia.

Way now seems clear for construction of long-considered pipeline from Hugoton area to take liquid products of several natural-gasoline plants to eastern Kansas for refinery blending. Plan is to slug L.P.G. through existing products lines to distributors in Great Lakes region at less than present rail costs.

Look for further progress in perfecting and applying theoretical calculations for predicting oil recovery from depletion-type reservoirs. Just completed are new correlations of such data as relative permeability, oil gravity, gas-oil ratio, and effect of formation fracturing which give increasingly good results in forecasting both primary and water-flood recovery.

Reports of oil-company activity in uranium exploration are greatly exaggerated. Flocks of promoters, some with oil in firm name, are noisily active, but established oil companies, except for a couple which have been in the business for some time, are only mildly interested in possibilities of running across uranium as byproduct of oil exploration.

The OIL AND GAS JOURNAL

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SPECIAL REFINING SECTION

Catalytic Refining Processes 140-176

Here are flow sheets and flow descriptions of 24 catalytic processes. These constitute the heart of modern petroleum refining. There are six catalytic cracking processes, nine catalytic reforming processes, three alkylation processes, five hydrogenation processes, and one polymerization process. Special emphasis is given to typical yields and other operating results.

What's Ahead for Catalysis? 177

Here are statements on the future of catalysis in petroleum refining by 10 men representing major oil companies and design companies. Predicted are: catalytic cracking of crude residua in shale oil, higher octane from paraffinic naphthas, increased yields of middle distillates, and increased fuel qualities. Needed for the future are: pilot method for testing catalyst that gives realistic commercial results, better catalysts, and increased knowledge of mechanism of catalysis.

Catalysis—How It Works 184

By Alex G. Oblad

Dr. Oblad gives a brief history of catalysis, a survey of the present state of the art, and predicts the future status of catalysis in the oil business. This is the first time this has been done in one article anywhere. It is comprehensive, yet simply written. Included are definitions of terms used in catalytic work, a discussion of reaction kinetics, nature of active centers, mechanisms of catalytic reactions used in refining petroleum, and mechanisms of metal catalyzed reactions.

Cat Cracker Turnaround 199

By Robert M. Cooper and Alex E. Shaw

Planning for the first turnaround of Sinclair's Houston refinery fluid unit was begun 6 months in advance. Work was divided into "pre-shutdown" and "shutdown" categories. The major jobs known to be required during the shutdown were planned in detail in advance. Manhour requirements were evened out by the pre-shutdown work and by staggering the major jobs.

Diesulforming—New Desulfurization Process 203

By F. B. Odaz and J. V. Sheffield

Decarbonizing Process Improves Flexibility 205

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Refinery Capacity Survey 208

By John M. McGivern

The Journal's 1955 Survey of North American Refineries show that United States refineries boosted capacities to nearly 8.7 million barrels daily by January 1, 1955. Capacities of Canadian refineries on this same date totaled nearly 610,000 bbl.

Refinery Construction Survey 236

By John M. McGivern

The 1955 Journal construction survey shows approximately 2 million barrels of capacity under way or slated to be started shortly.

Reduce Unscheduled Shutdowns 287

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Keeping the Refinery on Stream 300

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TECHNOLOGY—OPERATION

Faster Permian Basin Drilling 247

By R. J. Bromell

Permian basin drilling is much faster than it was 2 years ago. Weight on the bit has been increased, more drill collars are used, and more power is being applied.

Progress in Metals 253

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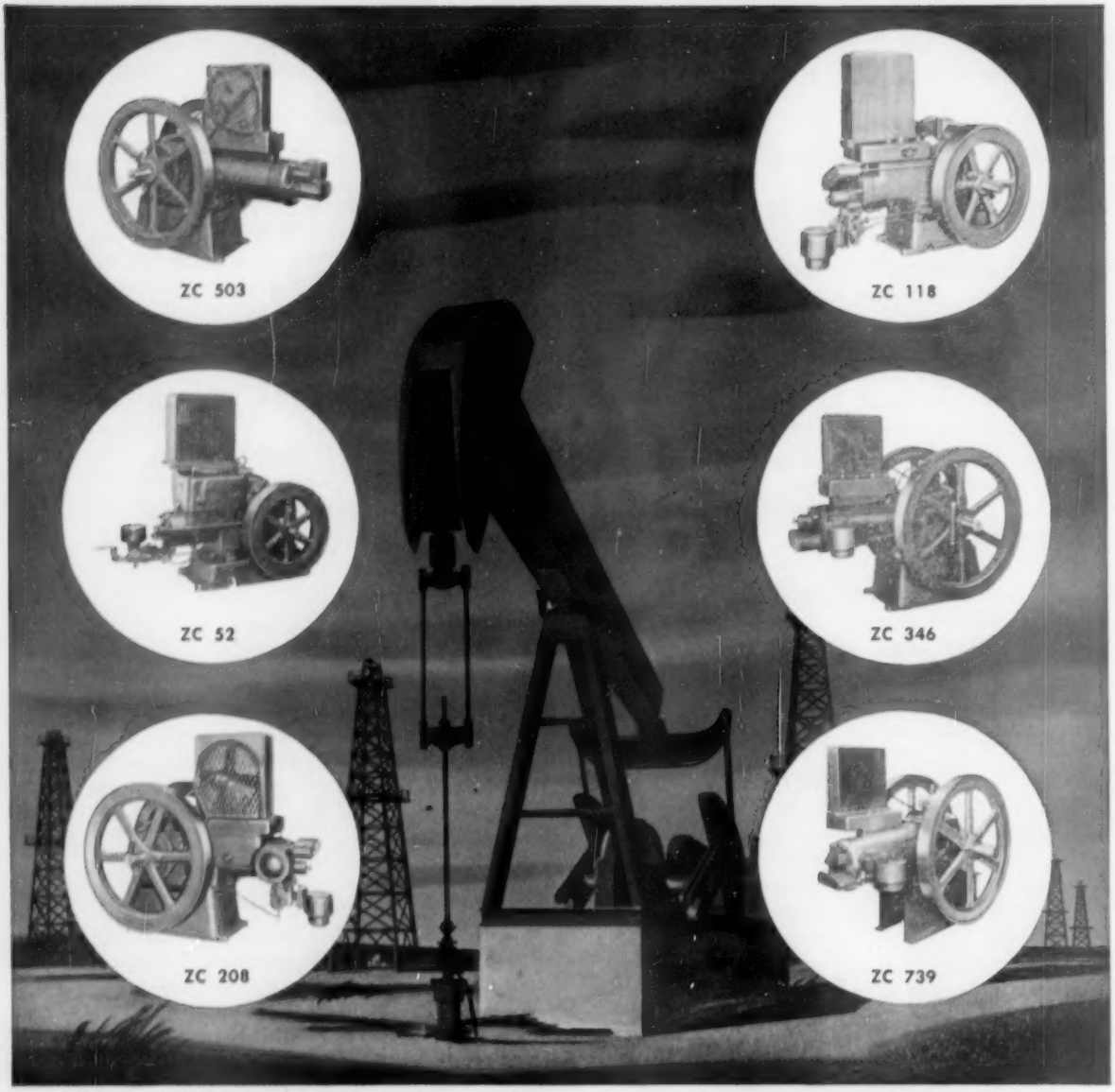

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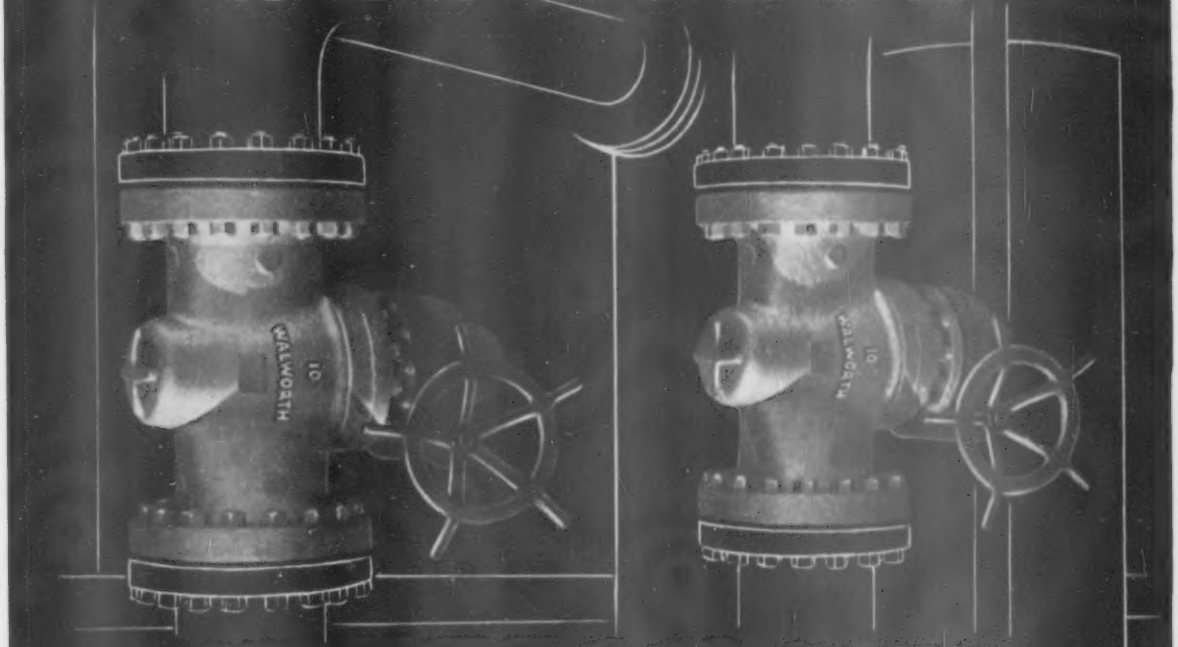

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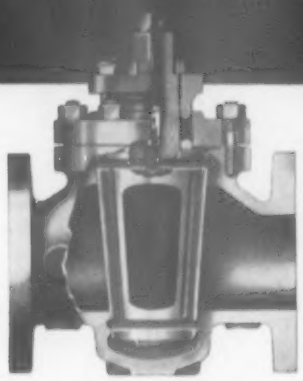

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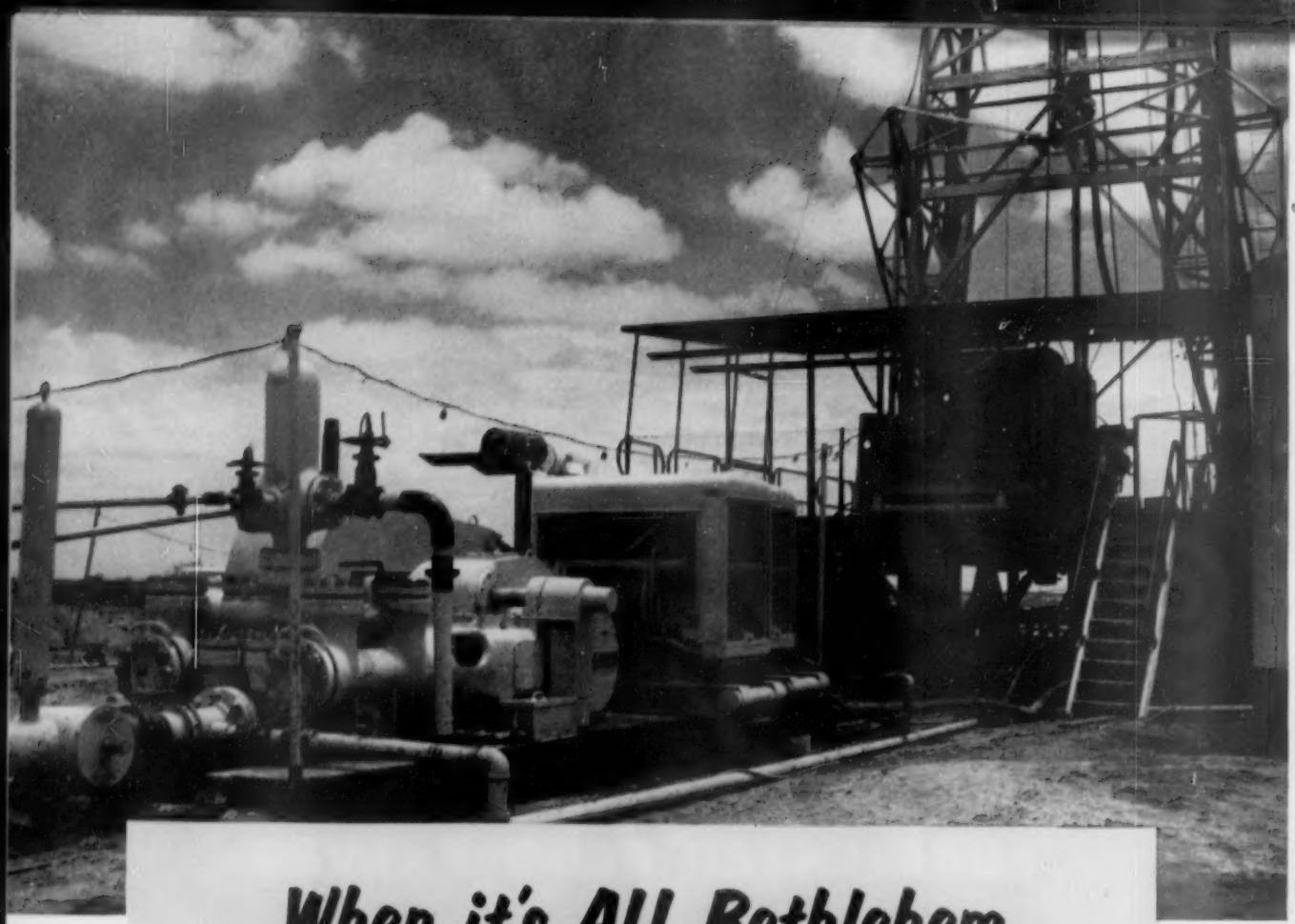

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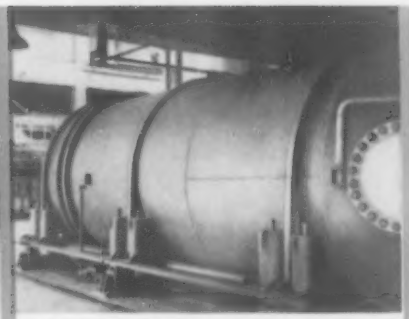
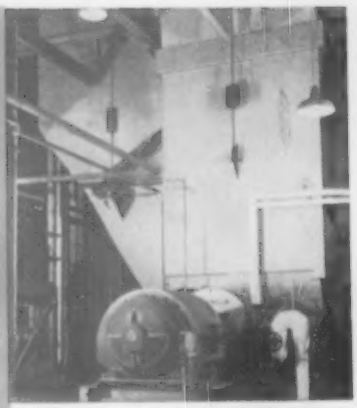


Grinnell Spring Hangers on large vessel of catalytic cracking unit in oil refinery.



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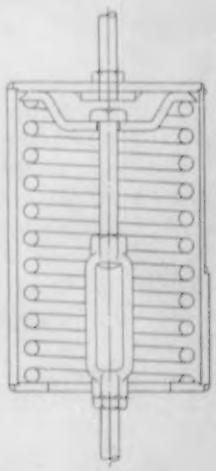
- Installation is simplified by integral load scale and travel indicators.

*Precompression is a patented feature.



VARIABLE SPRING HANGER FIG. B-268

Fig. B-268, Type A, is designed for attachment to its supporting member by screwing a rod into a bushing in the top cap of the hanger. Adjustment of the hanger load is accomplished by turning the turnbuckle on the lower hanger rod until the hanger picks up the load and the load indicator points to the desired position. Six other types of attachment are available.

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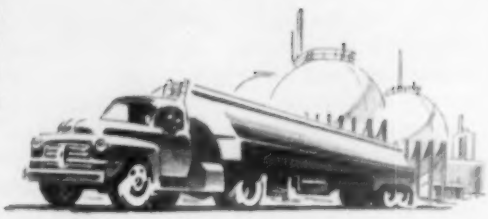

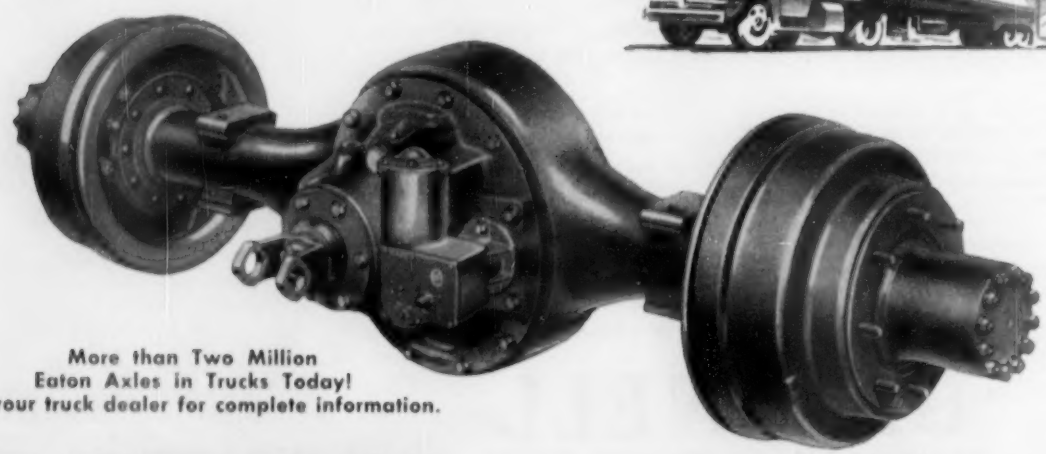

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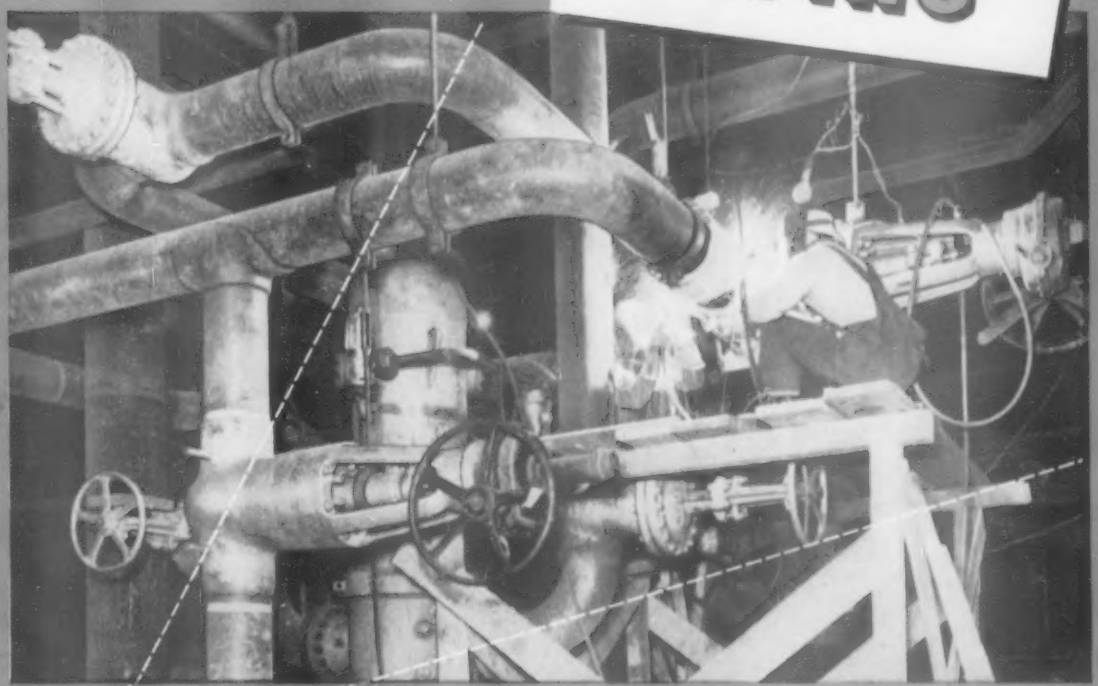


THAN MEETS THE EYE

Here you see carefully qualified Midwest welders erecting the boiler feed piping in a new public utility steam-electric generating station. What you don't see are the many other highly skilled men who contribute to the high quality of Midwest Piping.

First, there are the expert piping engineers who prepare the job for fabrication. They simplify the field work and make sure the difficult operations are done in the shop. And they often make suggestions that improve the design and reduce the cost of the piping.

Then there is the experienced shop organization (working with the most modern equipment) that delivers to the field subassemblies which are accurate in dimension, correct in alignment, thoroughly cleaned, heat treated when necessary, carefully inspected and tested . . . ready for erection at lowest cost. Both the shop and field supervisory personnel have come up through the ranks and know every phase of the operations . . . how to assure the customer the most for his money when he buys Midwest Piping.

MIDWEST PIPING COMPANY, INC.

Main Office, 1450 South Second St., St. Louis 4, Mo.

PLANTS: ST. LOUIS, PASSAIC, LOS ANGELES, and BOSTON

SALES OFFICES: NEW YORK 7—50 CHURCH ST. • BOSTON 27—426 FIRST ST. • LOS ANGELES 33—520 ANDERSON ST. • CHICAGO 3—79 WEST MONROE ST. • TULSA 3—224 WRIGHT BLDG. • HOUSTON 2—1213 CAPITOL AVE. • CLEVELAND 14—616 ST. CLAIR AVE.

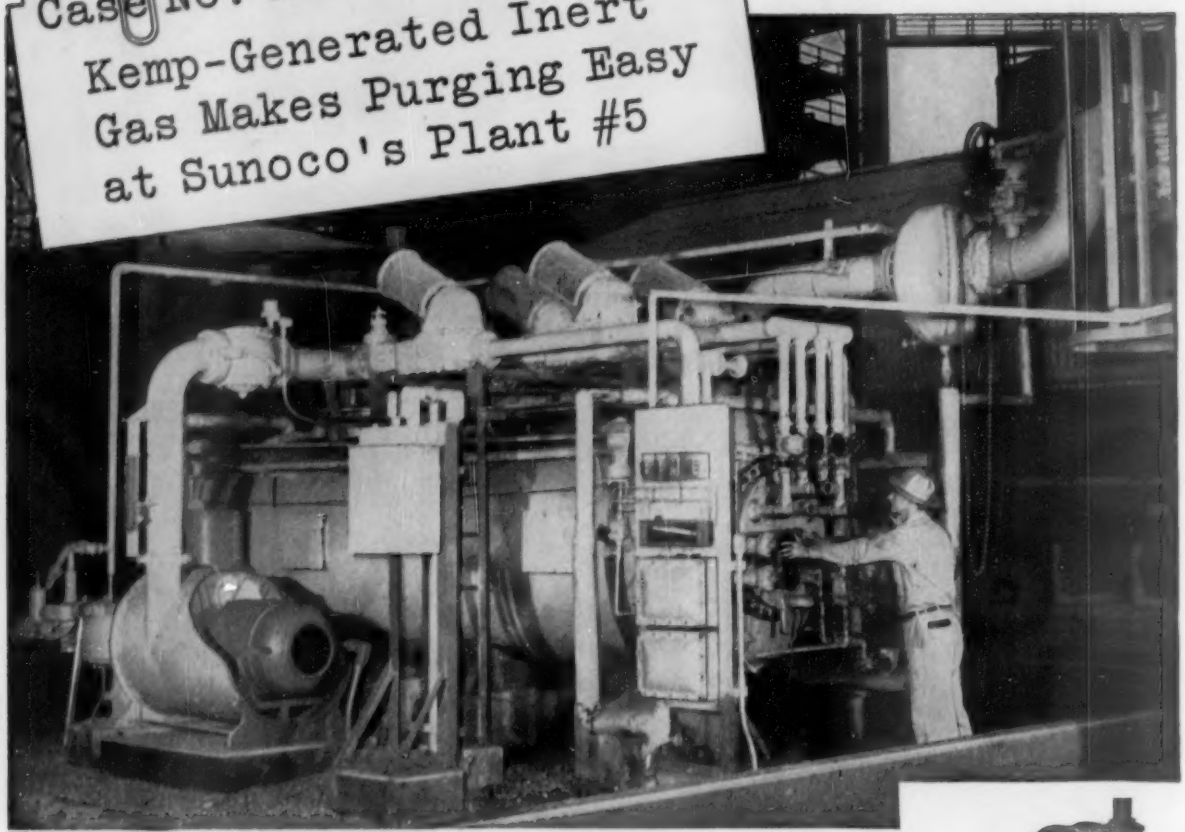
6493

MIDWEST

PIPING FABRICATION and CONSTRUCTION

OFFERS YOU MANY BENEFITS

Case No. 57
Kemp-Generated Inert Gas Makes Purging Easy at Sunoco's Plant #5



How Sun Oil's "Magic Mill" at Toledo operates with 'round the clock safety

There's no *one* word that strikes terror in the hearts of oilmen everywhere more quickly than F-I-R-E! To combat this threat at the Sun Oil Co.'s giant refinery at Toledo, Ohio, constant vigilance, checks and inspections are the answer. And the liberal use of inert gas for purging pipelines, tanks and crackers is essential to this safety maintenance.

Kemp selected to do the job

When plans called for *doubling* plant production in 1950, a new Kemp Generator (see above) was installed to insure adequate inert gas production. Fast-starting, easy-to-operate, this Kemp unit more than filled the bill. Today tanks and lines are periodically purged for inspection and cleaning *as often as needed*. And thanks to its 60,000 cu. ft. per hr. Kemp Inert Gas Generator, Sunoco enjoys *exact analysis* inert production that meets all its purging requirements.

Let Kemp help you, too

If you have a purging or blanketing problem, why not let Kemp Engineers give you the same helpful advice used so profitably at Sun Oil's Toledo refinery. It costs you nothing to investigate. And it may save you money. Find out how Kemp's wide range of dependable, low-cost Generators (complete with the latest fire checks and safety devices) offer you the best way to solve your problems.

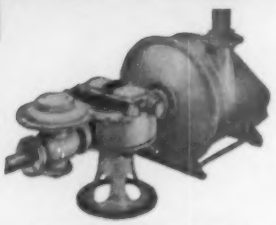
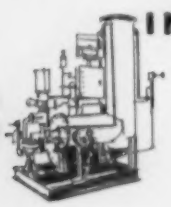


Photo above shows close-up view of Kemp Industrial Carburetor, the heart of every Kemp installation. Assures complete combustion... without waste, without tinkering. Reduces installation costs, simplifies maintenance.

For more complete facts and technical information, write for Bulletin I-10 to **C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.**

KEMP OF BALTIMORE



INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS • SINGEING EQUIPMENT

Inner valves are machined on duplicating lathes to exacting standards. In this photo, master contour plate on lathe at (A) automatically duplicates the exact contour desired at (B) to form the inner valve.

Precision parts on BS&B Controls are manufactured to close tolerances. This lathe operator "mikes" inner valve for a final tolerance of .001". Other parts require tolerances of as little as 3/10,000"

In Automatic Controls, BS&B Means..."Trouble-Free"!

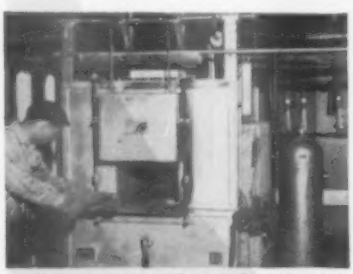
Ample production facilities and stocks of material assure prompt deliveries on all standard items in the BS&B Controls line.

Whenever you buy an automatic control, you look for the finest and most dependable one you can find for the job from the standpoint of quality, precision, long life and *"freedom from trouble."*

Freedom from trouble is especially important, because once a control is installed in the line, any "down-time" caused by its faulty operation becomes very expensive--usually many times more expensive than the entire cost of the control itself.

That's why it *always pays* to specify and buy BS&B Automatic Controls! Because of their superior quality and their long trouble-free performance, they'll *pay for themselves* in almost no time!

A Sinusoidal waveform apparatus is used to check the accuracy and performance of a BS&B Type 1440 Pressure Control Pilot.



Proper treating and hardening of certain component parts of BS&B Controls in one of these precisely controlled electric annealing furnaces is just one of the important manufacturing operations which assures their high quality and long trouble-free service.

Every BS&B Control must pass rigorous operating tests in our modern hydraulic testing and experimental laboratory. In this view, valves in the line are under test pressures from hydraulic pumps in the foreground. Operator checks readings on the control panel for valve performance.

EFFICIENCY OVER 40 YEARS BS&B RELIABILITY

BLACK, SIVALLS & BRYSON, INC.

84 Sales Centers — Controls Division, Dept. 4-A3 — 40 Stocking Points

7500 East 12th Street, Kansas City 26, Missouri

BRAND-NEW FIRE KILLER!

"WOW- trigger release for fast action!"
"HEY- pistol grip for easy handling!"
"SEE- new dust and moisture-proof gauge shows pressure at a glance!"
"BOY- powder won't pack, can't clog extinguisher!"
"LOOK- diffuser horn gives wider coverage in any position!"
"SAY- has reinforced bottom, won't topple over!"
Kidde
DRY CHEMICAL FIRE EXTINGUISHER

Leave it to Kidde to come up with a red-hot idea like this — a big, new 10-pound dry chemical extinguisher that's effective at *any* pressure from 150 to 250 pounds!

Naturally, this new Kidde 10-pounder has all the special features that make the Kidde Dry Chemical line second to none — fast action, easy handling, simple trigger operation, and extra-wide coverage that snuffs out fire in seconds. But the "wide operating range" feature is what makes the 10-pounder a real standout!

Unlike other extinguishers, which usually operate at one pressure only, the Kidde 10-pounder works through an extremely wide pressure range. Even when charged as low as 150 pounds, the Kidde 10-pounder is UL-approved for Class B and C fires. Boost the charge to *250* pounds, and you have a fire extinguisher with an *extra* hard-hitting punch!

For fighting fires in deep-burning liquids, electrical machinery and other hard-to-get-at places, *nothing* beats a Kidde Dry Chemical Extinguisher. See to it that *you* have Kidde protection. Call Kidde today!

Kidde

The words 'Kidde', 'Lux', 'Lux O-Matic', 'Fyre-Freez' and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

Walter Kidde & Company, Inc.
354 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal—Toronto

SPEEDY SQUEEZING
on the toughest job

with
HALLIBURTON'S
hydraulic
RETRIEVABLE CEMENTER

The best recommendation for any cementing tool is a record of successful operation under difficult conditions. Halliburton's Hydraulic Retrievable Cementer has earned its reputation for *fast, dependable* and *successful* operation under the highest pressures and most difficult conditions on thousands of jobs.

Speed is built into the rugged Cementer that can be set, released and reset any number of times without surfacing. With this retrievable advantage, there is never any metal to drill out or loss of costly rig time!

The tool can be rapidly run into hole on drill pipe or tubing without overflow of fluid. Special friction drag blocks allow the tool to be started without difficulty. And tubing may be tested to 10,000 p.s.i. while setting the packer, because the lower end of the stinger is blanked off while the slips and packer rubbers are set by hydraulic pressure. This positive hydraulic action and simple design explain the dependability of the Hydraulic Cementer. Settings are not dependent on the pulling capacity of the rig or amount of tubing weight, and after the tool is set the packer will hold pressure from above or below without putting a strain on tubing.

With these and other exclusive advantages, it's easy to understand *why* the Hydraulic Cementer has earned a record of dependable and economic service. But you'll know best just *how* important this record is after using the Cementer on your own well. Call for the Hydraulic Retrievable Cementer for your next job—it comes from the world's most experienced cementers. Call your local or district office of the Halliburton Oil Well Cementing Company.

HALLIBURTON

CEMENTING SERVICES

211 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG

PROVEN by 8 years

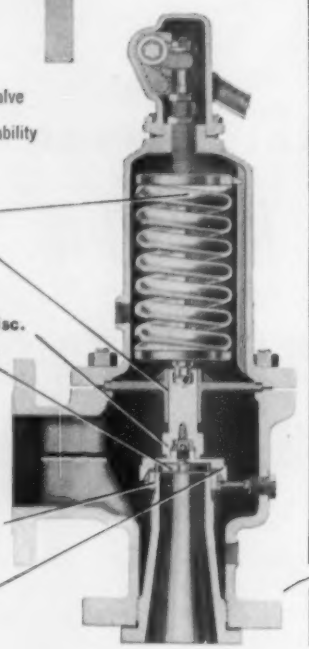
THOUSANDS of Successful Installations of Farris "4 in 1" Safety Relief Valves*

NOTICE: Farris Safety Relief Valves, the Internal Heat Exchanger, and Bellows construction are covered by U.S. Patents and Patents Pending. Copyrights, where applicable, are registered.

1 STANDARD FULL NOZZLE SAFETY RELIEF VALVES

Here is the ultimate in nozzle valve construction with complete standardization and interchangeability in every part:

- **Round wire springs calibrated for rating.**
- **2½ to 1 guiding ratio, close tolerances.**
- **Alignment spool for perfect alignment and bearing from stem to disc.**
- **Self-aligning, optically-flat replaceable disc of forged Stainless Steel.**
- **All bearings of hardened Stainless Steel.**
- **Expanded orifices increase capacity.**
- **Single blowdown ring does not affect capacity—simple adjustment.**
- **Flared disc-holder for ultimate operating efficiency.**



BALANSEAL© SAFETY RELIEF VALVES

BalanSeal construction isolates all working parts. It consists of a neutral area bellows equalling the area of the seating surface, incorporating a mechanically-held seal for the lower part to greatly enhance replacement. BalanSeal can be simply installed any time. Because BalanSeal neutralizes effects of back pressures, resulting in a constant, safe relieving point on the upstream side, size of back pressure piping can be drastically reduced—for pipe savings up to 15 times the cost of the valve! Where accurate set points must be depended upon, BalanSeal stands alone.

For eight years Farris has been setting-the-pace-in-safety with "4-in-1" Safety Relief Valves, the "standard" for long service life, minimum maintenance and positive protection.

Farris' recognition as the pace-setter of the industry is no accident, but the result of many engineering "firsts" in improved valve design—FIRST with balanced bellows construction . . . FIRST to offer multiple nozzle sizes within one valve . . . FIRST with a line of bar stock safety-relief valves for pressures to 10,000 lbs. . . . FIRST to offer internal heat exchangers . . . FIRST to offer realistic pricing, giving the customer the benefit of manufacturing economies . . . and only Farris can point to proved-in-service performance . . . because Farris is the pioneer manufacturer of safety relief valves with bellows.

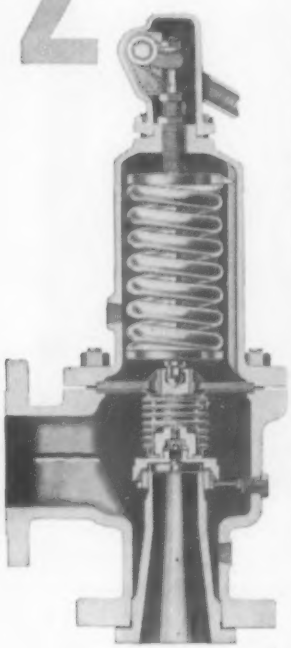
FOR ENGINEERS: Catalog 48Ra on the full line of Farris Safety Relief Valves; and Technical Manual 51B—"Principles of Manifold Discharge Piping". Available on request.

"THE FOX AND THE HARE"

Send for this popular entertaining pamphlet presenting a story about the recognition of BALANSEAL valves. It is humorous and enlightening. Just ask for it by name.

# of ACTUAL SERVICE

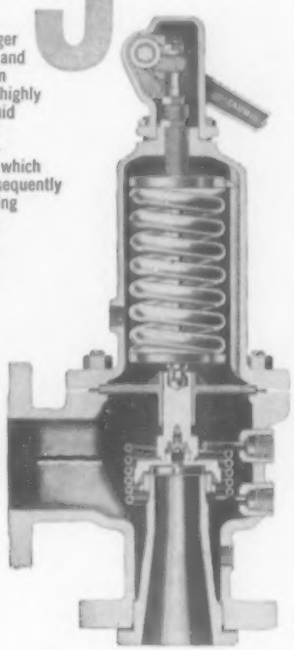
2



INTERNAL HEAT EXCHANGER

The exclusive Farris Internal Heat Exchanger eliminates inefficient and costly steam tracing in a valve body to keep highly viscous media in a fluid state. It consists of a stainless steel coil inserted in the body to which steam is fed and subsequently trapped out. For placing heat where it is most effective, increasing efficiency, lowering steam consumption, the Farris Internal Heat Exchanger is the only available product of its kind.

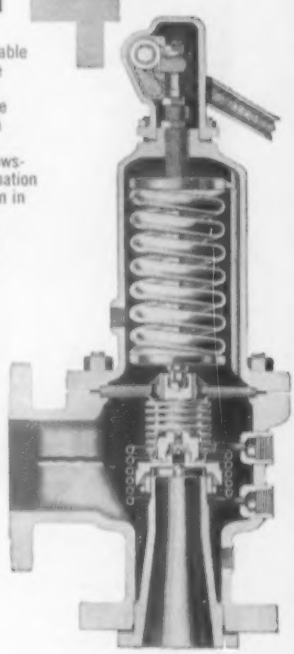
3



BELLOWS—HEAT EXCHANGER COMBINATION

For completely dependable valve operation in spite of sticky fluids (tars, asphalt, etc.) and where complete freedom from contamination is required, select the Bellows-Heat Exchanger combination . . . The ultimate design in safety relief valves for applications where material is highly viscous. All parts are Farris Standard construction.

4



*** CERTIFIED AND APPROVED by the National Board of Boiler and Pressure Vessel Inspectors, complying with ASME requirements. Tests made at university laboratories by independent observers. Certification data available on request.**

and Still the Lowest Prices in the industry!

Coming Soon!

An added line of ultimate capacity nozzle valves

Farris ENGINEERING CORPORATION

420 COMMERCIAL AVENUE, PALISADES PARK, NEW JERSEY

Affiliates: Farris Flexible Valve Corp. • Farris Stăcon Corp. • Farris HydroTorque Corp. Farris HydroSeal Corp. • Farris Pickering Governor Co.

GM DIESEL
CASE HISTORY No. ID2B-86

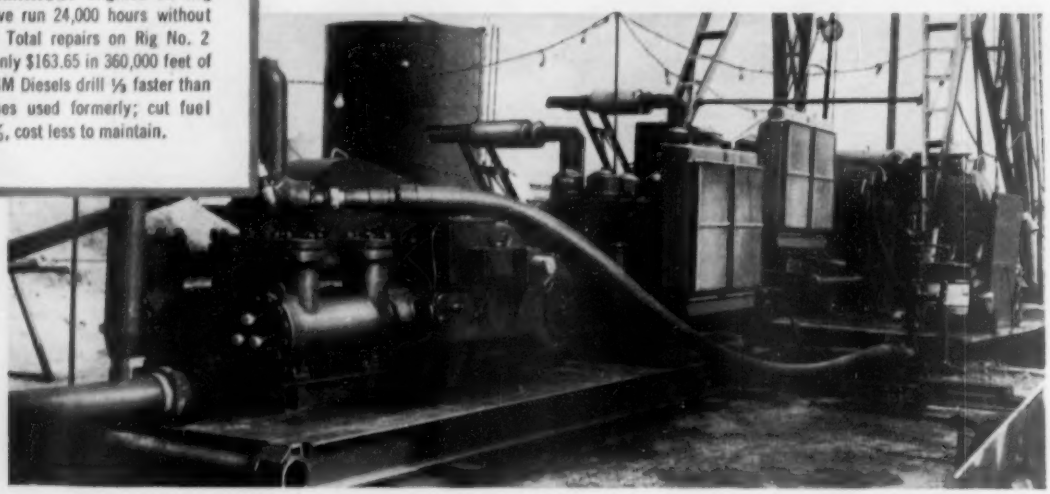
OWNER: Empire Drilling Company, Wichita, Kansas.

INSTALLATION: Two GM Twin "6-71's" drive National Supply draw works and Ideal mud pumps. Empire owns two rigs of this type.

PERFORMANCE: Engines on Rig No. 1 have run 24,000 hours without overhaul. Total repairs on Rig No. 2 came to only $163.65 in 360,000 feet of drilling. GM Diesels drill ⅓ faster than gas engines used formerly; cut fuel costs 33%, cost less to maintain.

Drills ⅓ Faster, Cut Fuel Costs 33%

Since he Switched from Gas to General Motors Diesel Power



Dan Kornfeld of Empire Drilling grew up on the end of a pipe wrench. He says, "You can't beat the performance of GM Diesels. I've got the extra power I need for jet bits and, with less weight per horsepower, I can move faster and easier."

You'll make hole faster with General Motors Diesels on your rig. These compact 2-cycle engines deliver power on every piston downstroke—accelerate faster, respond to throttle controls quicker.

And moves will be faster, easier and cheaper, too, because a GM Diesel packs more power in a smaller, lighter engine that's easy to load on trucks—fits road widths—requires no special road permits.

A GM Diesel is easy to service and maintain. There are no troublesome high-pressure fuel lines—simple unit injectors are almost as easy to change as a spark plug. It burns fewer gallons of regular Diesel fuel that's available no matter where you're drilling.

These engines are backed by a widespread distributor organization that supplies fast service and quick parts delivery day or night. Call your GM Diesel distributor or supply house for more information on GM Diesel power or write direct for full details.

It Pays to Standardize on

DETROIT DIESEL ENGINE DIVISION

GENERAL MOTORS • DETROIT 28, MICHIGAN

Single Engines . . . 30 to 300 H. P. Multiple Units . . . Up to 893 H. P.

GM GENERAL MOTORS DIESEL POWER

GENERAL MOTORS CORP., DIESEL ENGINE SALES, PETROLEUM INDUSTRY, 1504 PHILTOWER BLDG., TULSA, OKLAHOMA

ALABAMA—
Albertville, Birmingham, Montgomery
ARMSTRONG EQUIPMENT CO.

CALIFORNIA—Bakersfield
LAWLESS BROTHERS, INC.
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WEST COAST ENGINE & EQUIPMENT CO.
El Cajon
DEAKINS-LANE DIESEL CO.
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DIESEL EQUIPMENT CO.

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GEORGE ENGINE CO., INC.
Shreveport
UNITED TOOL CO.

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EARLE EQUIPMENT CO.

MISSISSIPPI—Jackson
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WESTERN MACHINERY & ENGINE CO.

NEW MEXICO—Albuquerque
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NORTH DAKOTA—Williston
SWEENEY BROTHERS

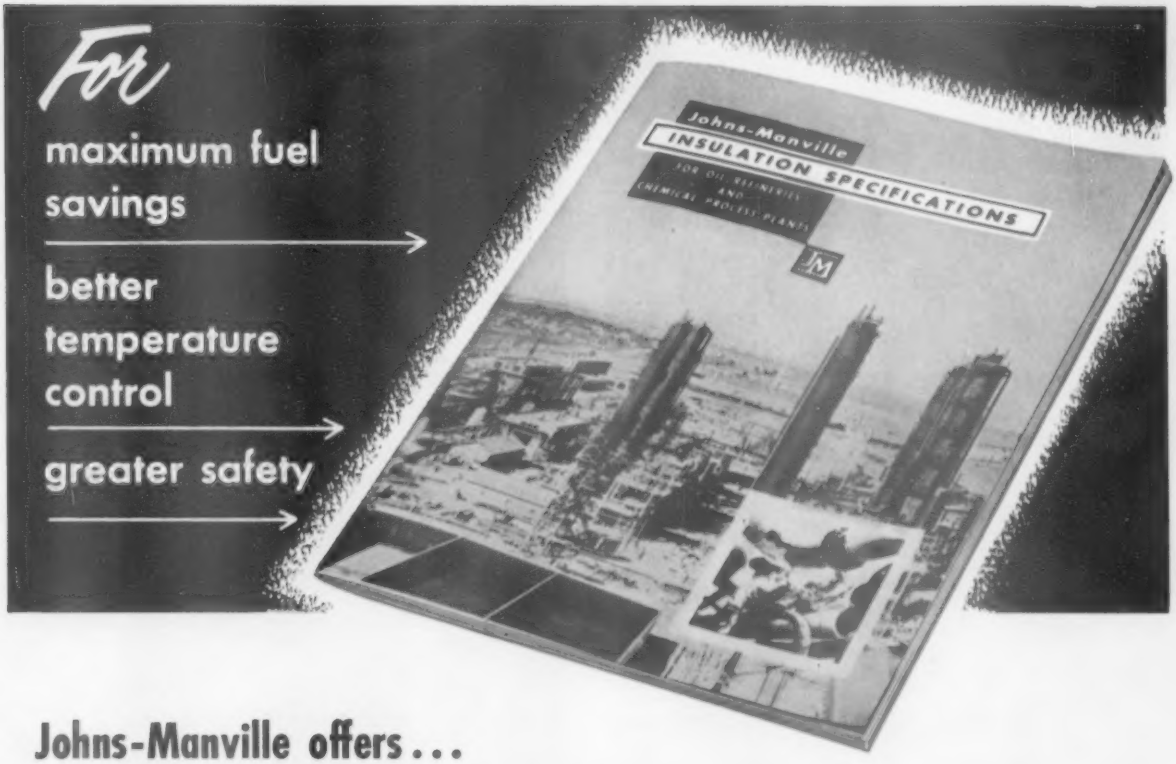
OKLAHOMA CITY—Oklahoma City, Tulsa
DIESEL POWER CO.

TEXAS—Corpus Christi, Dallas, Houston, Lubbock, Odessa, San Juan
STEWART & STEVENSON SERVICES, INC.
Plainview
DIESEL POWER, INC.

UTAH—Moab, Salt Lake City
CATE EQUIPMENT CO., INC.

WYOMING—North Casper
WESTERN OIL TOOL & MFG. CO., INC.

IN CANADA—Distributors in all key locations, under
GENERAL MOTORS DIESEL, LTD.
London, Ontario



Johns-Manville offers...
new 52-page THERMAL INSULATION SPECIFICATIONS manual

For the oil refining and chemical process industries—the most complete manual of thermal insulation specifications ever offered! It contains 52 pages of data, specifies the correct insulations and methods of application for equipment in every temperature range encountered in these industries. Vessels, tanks, flues, pipes, breechings, stacks, vacuum filters, oil heaters and many other types of equipment are included.

Johns-Manville offers industry undivided responsibility for all thermal insulation requirements. J-M complete insulation service includes:

J-M Materials—for every temperature requirement from minus 400F to plus 3000F. The many different kinds and forms of J-M Insulations include pipe insulation, sheets, blocks, bricks, blankets, insulating cements and fills, insulating papers and felts.

J-M Engineering—to provide the technical knowledge needed to specify the correct insulation for maximum performance. Johns-Manville has almost a century of experience in insulation engineering. It has the world's largest insulation laboratory for the development of new and improved products.

J-M Application—to insure long, trouble-free service. J-M Technical Service Units and J-M Insulation Contract Units are located throughout the country. They are staffed with men skilled in the application of Johns-Manville Insulations according to proven and successful J-M methods.

Mail coupon for your copy of manual.

This Johns-Manville manual of Thermal Insulation Specifications is offered as a service to the oil refining and chemical process industries.

JOHNS MANVILLE JM PRODUCTS

Johns-Manville

***FIRST IN* INSULATION**

MATERIALS • ENGINEERING • APPLICATION

Johns-Manville, Box 60, New York 16, N. Y.
In Canada, 199 Bay St., Toronto 1, Ontario

Please send me without charge copy of your Insulation Specifications, IN-128A

Name _____ Title _____

Company _____

Address _____

City and Zone _____ State _____

TIMKEN® seamless tubing eliminates drilling, saves steel and machining time!

NO need to bore out bar stock to make hollow parts when you use Timken® seamless tubing. The center hole's already there! You don't waste steel but only pay for the steel you use.

Because you don't have to bore the center hole, you save machining costs, too. Finish boring is often your first production step. Screw machine stations can be released for other jobs. So you add machining capacity without adding machines.

Our engineers will save you even more money, too, by studying your problem and recommending the most economical tube size for your hollow parts jobs.

You're assured of the highest internal quality with Timken seamless tubing. The piercing process by which it's made is basically a forging process. It has a uniform spiral grain flow for greater strength, and a refined grain structure which brings out the best quality of the metal. And the Timken Company's rigid quality control keeps this quality uniform from tube to tube and heat to heat. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

helpful refinery service that pays for itself!

TRETOLITE DESALTING

is used to desalt over one and one-half million barrels of crude oil daily. Salt removals are in the range of 95 to 100%, with chemical costs averaging around 2 mills per barrel. Regardless of the capacity requirement, Tretolite desalting offers a simple, flexible and economical answer.

OTHER TRETOLITE PRODUCTS AND SERVICES FOR REFINERS

Water Clarification Compounds
Demulsifiers for Waste Oil Emulsions
Demulsifiers for Doctor Treating
Anti-Foam Compounds
Asphalt Anti-Stripping Additives

KONTOL Corrosion Inhibitors

protect internal metal surfaces by forming a protective mono-molecular film. They also offer excellent detergent properties which assure the advantages of operations with clean units. Kontol inhibitors are available in numerous formulas, suitable for use in the various corrosive environments encountered in the refinery.

For complete information, ask your Tretolite refinery service engineer or write to

TRETOLITE COMPANY
A DIVISION OF PETROLITE CORPORATION
369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

AR 559

In Golf... Experience and Accuracy make a Champ

In Wire Rope

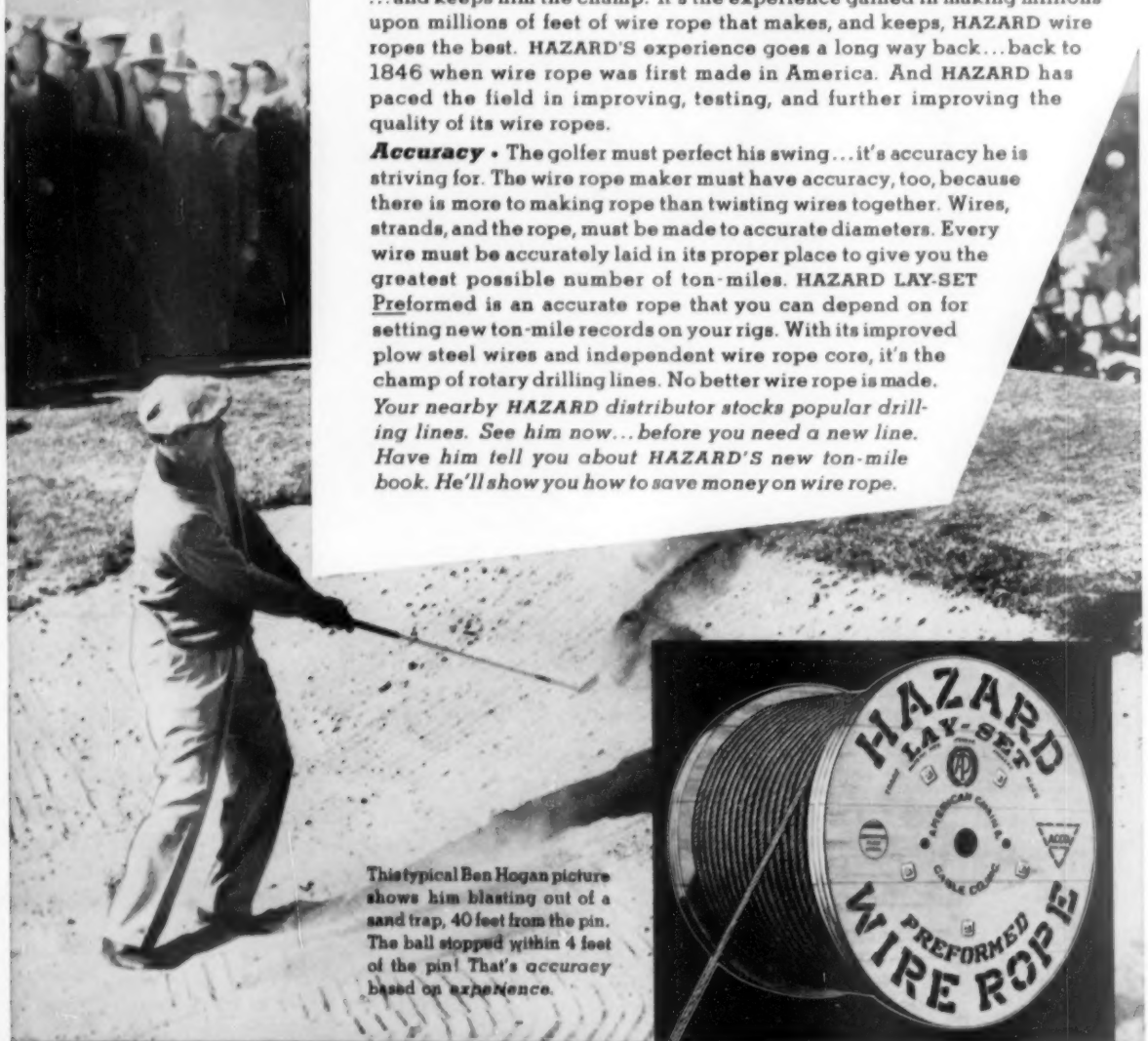
Experience and Accuracy count, too

...and ***HAZARD*** has both

Experience • It's the grind of game after game that makes a golf champ ...and keeps him the champ. It's the experience gained in making millions upon millions of feet of wire rope that makes, and keeps, HAZARD wire ropes the best. HAZARD'S experience goes a long way back...back to 1846 when wire rope was first made in America. And HAZARD has paced the field in improving, testing, and further improving the quality of its wire ropes.

Accuracy • The golfer must perfect his swing...it's accuracy he is striving for. The wire rope maker must have accuracy, too, because there is more to making rope than twisting wires together. Wires, strands, and the rope, must be made to accurate diameters. Every wire must be accurately laid in its proper place to give you the greatest possible number of ton-miles. HAZARD LAY-SET Preformed is an accurate rope that you can depend on for setting new ton-mile records on your rigs. With its improved plow steel wires and independent wire rope core, it's the champ of rotary drilling lines. No better wire rope is made.

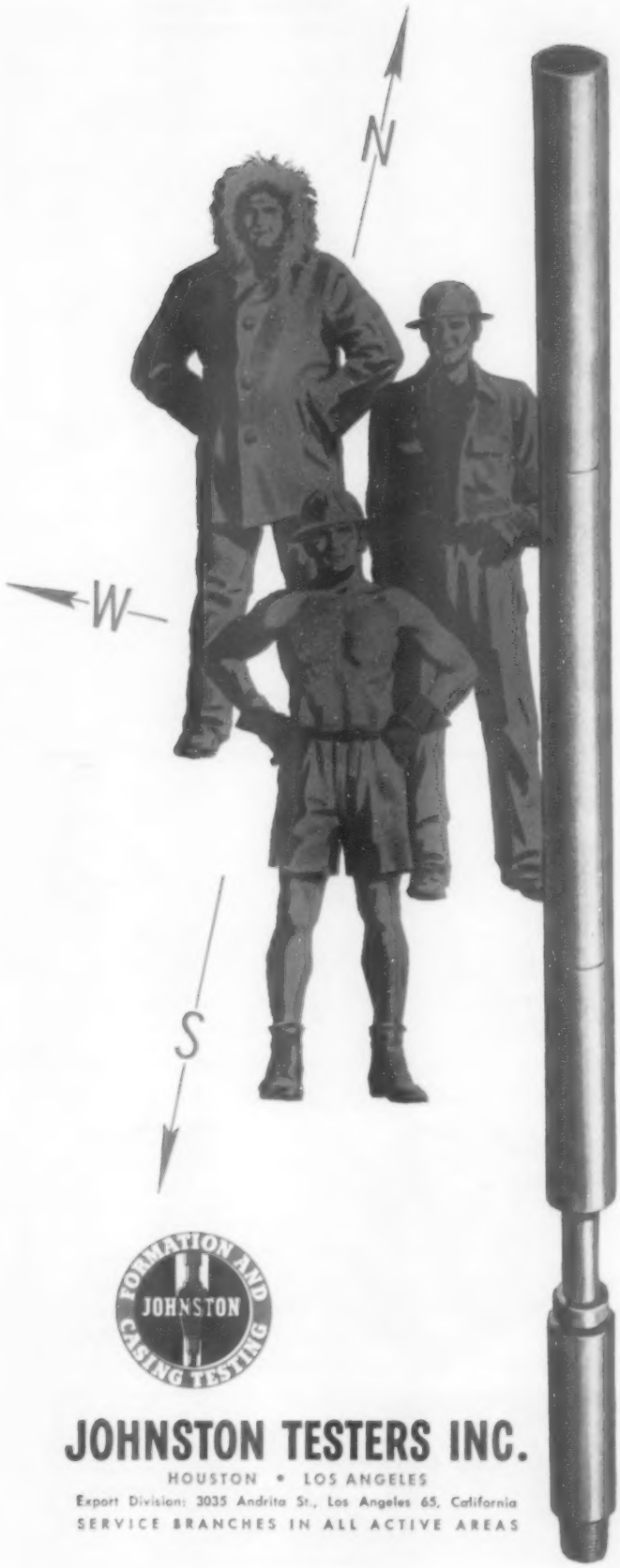
Your nearby HAZARD distributor stocks popular drilling lines. See him now...before you need a new line. Have him tell you about HAZARD'S new ton-mile book. He'll show you how to save money on wire rope.



This typical Ben Hogan picture shows him blasting out of a sand trap, 40 feet from the pin. The ball stopped within 4 feet of the pin! That's *accuracy based on experience.*

HAZARD WIRE ROPE DIVISION
American Chain & Cable Company, Inc.

PLANTS: Houston, Tex.; Wilkes-Barre, Pa.
OFFICES AND WAREHOUSES: Odessa, Tex., San Francisco, Portland, Ore.; Pittsburgh, Philadelphia, New York, Los Angeles, Denver, Chicago, Atlanta • Bridgeport, Conn.



From the Yukon to the Rio Grande

THE JOHNSTON-SUTLIFF HYDRAULIC JAR IS USED TO MEET ANY CONDITION

FOR ALL TYPES OF JOBS! Hits any desired blow . . . at any time. Changes to meet any condition without coming out of the hole.

Simplicity of operation, requires no torque. It is an exceptionally rugged self contained Hydraulic tool with only two moving parts. And is available in all drill pipe sizes.

During three years of use in oil fields everywhere it has become the standard on drill stem testing jobs.

FORMATION AND CASING TESTING — JOHNSTON

JOHNSTON TESTERS INC.

HOUSTON • LOS ANGELES

Export Division: 3035 Andrita St., Los Angeles 65, California

SERVICE BRANCHES IN ALL ACTIVE AREAS

S/K apades in industry

Once upon a time there was a Production Superintendent who radiated Btu's like a boiler gone berserk. He got that way because of balky pumps.

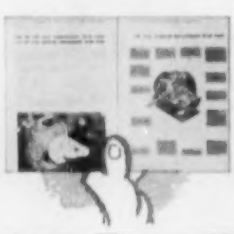
"It's a viscous circle," he snarled at his Assistant. "Every time we try to pump asphalt or hot road oil, these infernal pumps conk out. Lines get tied up. Tanks can't be cleaned. Barges and trucks can't be loaded. Process units shut down . . ."

"A truly deplorable state of affairs," sympathized the Assistant, "but not uncommon in refineries and petrochemical plants . . ."

"Do something about it!" roared the Production Super. "Find me some dependable pumps to handle viscous materials, or I'll make you a night watchman!"

"I never liked night work," said the Assistant. "So—here goes." He bolted into his office and dived into his data files.

THE CASE OF THE PAMPERED PUMPS AND THE SUPERHEATED SUPERINTENDENT

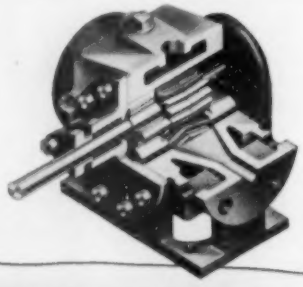


What he wanted was there! A copy of Schutte and Koerting Bulletin 17-A on Gear Pumps. Types, operating ranges, design features—just the information he needed. "Steam jacketed gear pumps," said the Assistant. "Could be. I'll have a talk with an SK Sales Engineer."

He did—and the SK pump expert was more than helpful. He asked some searching questions about materials to be handled, gave the Assistant a careful analysis of his problem—and came up with a specific recommendation.

MISSION ACCOMPLISHED—EASILY!

Installed over a whole area of pumping jobs, SK Fig. 1738 Steam Jacketed Herringbone Gear Pumps now handle viscous materials of many types, in a wide range of temperatures. Asphalt and road oils stay hot—and keep moving. The Assistant is now First Assistant. And the Production Super is operating at lower temperatures than he has in months!



MORAL:

Send for your copy of Bulletin 17-A on Gear Pumps. And when you're ready for more details, call in a specialist—your nearest SK Sales Engineer.

Schutte and Koerting COMPANY
MANUFACTURING ENGINEERS
3219 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Jet Apparatus • Heat Transfer Equipment
Strainers • Condensers and Vacuum Pumps
Oil Burning Equipment • Rotameters
Flow Indicators • Radiafin Tubes • Valves
Spray Nozzles and Atomizers • Gear Pumps
Desuperheaters

TYPE 8-B

at RICHFIELD'S NEW WATSON REFINERY

Here, at the largest and most modern refinery on the West Coast, you'll find a complete line of "John Crane" Seals. Specifically designed for refinery service, these seals were selected for their ability to handle difficult liquids.

For instance, you'll find Type 8-B Seals handling propane at 100°F., 700 psi., spg. 0.475 . . . Type 1-B Seals on 4-stage pumps handling liquids at 190°F., 500 psi . . . Type 2 Seals in ethane-butane service at 90°F., 235 psi . . . others handling gasoline at 110°F., 445 to 460 psi.

These seals, in combination with the "John Crane" Type 9 Seal (incorporating sealing member of DuPont Teflon), are used in refineries everywhere.

The "John Crane" Type 9 Seal is especially adapted to handling light hydrocarbons and similar services where rubber sealing members cannot be used because of high temperatures and corrosive action.

Refinery engineers should have our new and latest literature on "John Crane" Seals.

Crane Packing Company, 1819 Cuyler Avenue, Chicago 13, Illinois

Crane Packing Company
140 North Marine Avenue
Wilmington, California

Crane Packing Company
6626 Supply Row
P.O. Box 9411, Houston 11, Texas

Crane Packing Company
53 Stevenson Street
San Francisco 5, California

In Canada: Crane Packing Co., Ltd., 617 Parkdale Avenue, N., Hamilton, Ont.

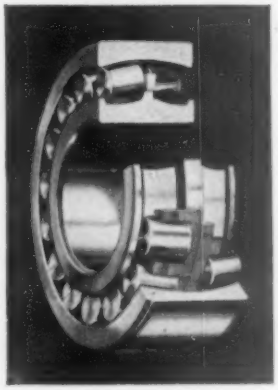
JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

IN THE OIL INDUSTRY, TORRINGTON *Bearings are used in many applications including slush pumps, rotary tables, draw works, blocks, swivels and pumping units.*

Courtesy of the Ohio Oil Co.

TORRINGTON Spherical Roller Bearings

are designed with machined, cast-bronze, land-riding cages—one for each path of rollers—to assure true rolling operation



Other TORRINGTON SPHERICAL ROLLER BEARING features are equally important in assuring top performance. Contact surfaces are precision ground for even load distribution, long bearing life. Rollers and races are carefully heat treated to give maximum resistance to shock and wear.

An integral center flange gives positive radial stability and accurate positioning of thrust loads—an essential factor for longer service life. Contact surfaces possess geometrical conformity, giving ultimate load carrying capacity.

These are reasons why TORRINGTON SPHERICAL ROLLER BEARINGS give you long, low-maintenance service in the toughest, heavy-duty applications. Get the most for your bearing dollar—specify TORRINGTON.

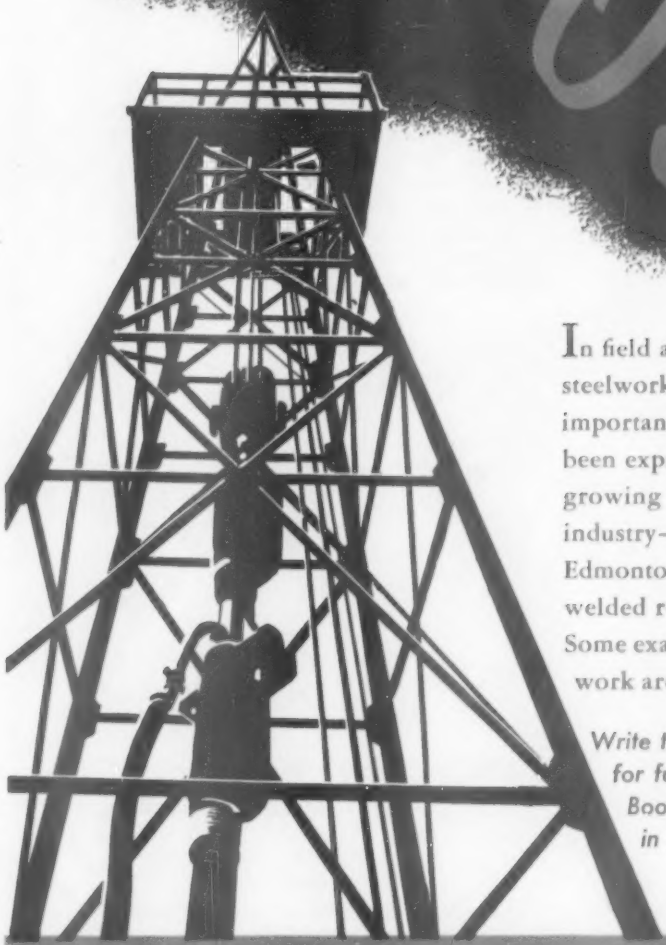
THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON SPHERICAL ROLLER BEARINGS

Spherical Roller - Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

SERVING CANADA'S *Oil Industry*



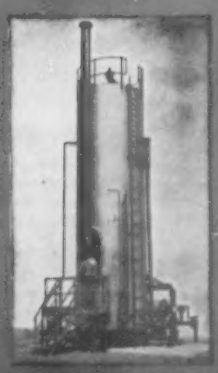
In field and refinery operations custom steelwork by Dominion Bridge plays an important role. Our Western plants have been expanded and re-equipped to meet the growing needs of Canada's thriving oil industry—including complete facilities at Edmonton for the fabrication of Class I welded refinery pressure vessels. Some examples of our work are shown below.

Write to Box 280, Montreal, for fully illustrated Booklet BSE "Builders in Steel".

DOMINION BRIDGE
COMPANY LIMITED

FRACTIONATOR TOWERS

TREATER UNITS



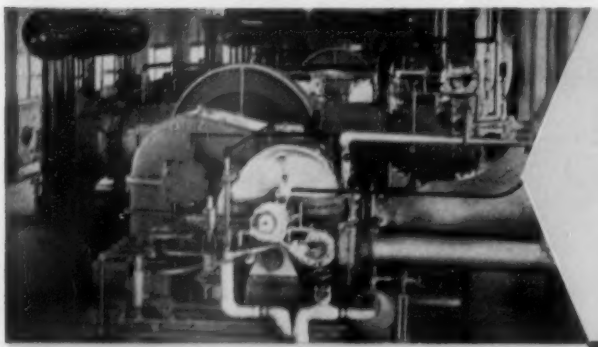
PUMPS

OIL STORAGE TANKS

DIVISIONS: STRUCTURAL, PLATEWORK, BOILER, MECHANICAL, WAREHOUSE

Plants at: MONTREAL, OTTAWA, TORONTO, WINNIPEG, CALGARY, VANCOUVER,
Assoc. Companies at: AMHERST, N.S. QUEBEC, SAULT STE-MARIE, EDMONTON

Need a long-life gear unit for refinery service?



SPEED REDUCERS

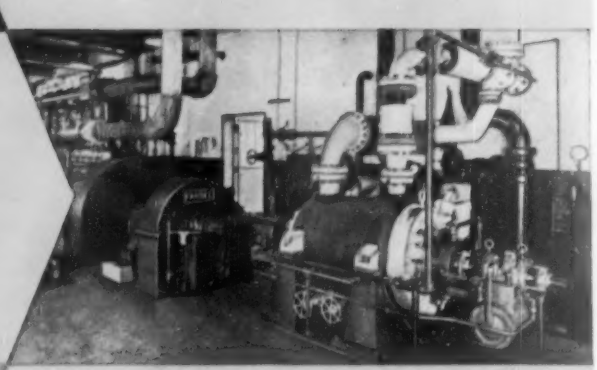
Farrel speed reducers are adaptable in critical detail. This results in the solution of innumerable application problems. Designs include single, double and multiple reduction units, speed change units, and drives to meet special requirements.

Shown at the left, are two double reduction gear units, each transmitting 920 HP at 4000 RPM to a compressor operating at 300 RPM.

SPEED INCREASERS

Farrel type SI gear units are specially designed for the high peripheral speeds encountered in speed increasing applications. Speed ratio range from 1:1 to 12:1 with one pair of gears. Special units having two sets of gears are made with ratio range from 12:1 to 40:1.

In the illustration at the right, a type SI unit is transmitting 375 HP and stepping up the speed from vertical gas engine to hot oil pump in refinery.



RIGHT ANGLE DRIVES

Type RA vertical drives are used extensively for either increasing or reducing speed from internal combustion engines or high-speed turbines to vertical pumps. Hollow vertical shaft, which permits easy adjustment of the pump shaft without disturbing gears or bearings, can be supplied.

At the left, two RA-20 vertical right angle units are transmitting 250 HP from steam turbines at 4000 RPM to deep-well water pumps at 1746 RPM.

When you choose Farrel, you get the gear unit that's right for the job. What's more, you're assured of *sustained* operating efficiency throughout a long service life, thanks to sound engineering, accuracy of manufacture, and use of highest grade materials.

The gears have precision generated teeth; shafts and bearings are factored to safeguard against interruption of vital processes; gear cases proportioned to withstand repeated heavy peak loads; joints sealed against dirt.

Detailed bulletins, on any of the gear units mentioned, available on request.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Akron, Detroit, Chicago, Memphis, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, New Orleans

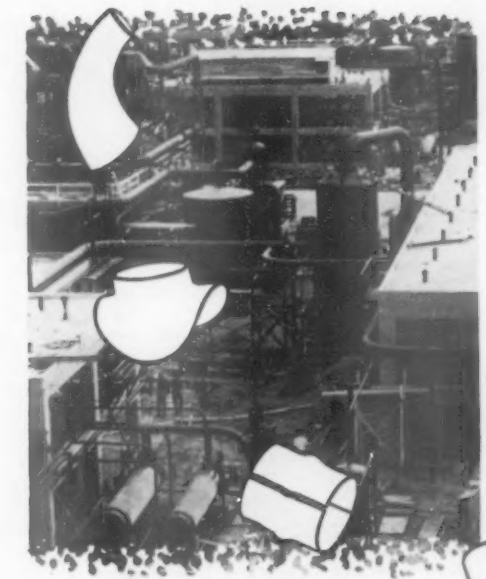
OIL FIELD REPRESENTATIVES:

Hercules-Lupfer Engine Sales Co., 124 N. Boston St., Tulsa 1, Okla.
V. W. Osborne, 860-A M&M Building, Houston 2, Texas
FB-996

Farrel-Birmingham®

3 IMPORTANT FACTS ABOUT MIDWEST WELDING FITTINGS

Check 'em



Midwest originated and developed the Long Tangent Elbow, the Reducing Elbow, Saddle, Sleeve, Shaped Nipple, and Lap Joint Stub End with large radius and heavy forged lap.

1 They are more ductile and have greater bursting strength than seamless pipe of comparable analysis.

2 They enable you to cut all pipe in exact accordance with designer's drawings. They are accurate and uniform.

3 The line is complete and varied. It gives you greater latitude in design and permits improvements and economies impossible to attain otherwise.

J&L STEEL

Jones & Laughlin STEEL CORPORATION
SUPPLY DIVISION—TULSA, OKLAHOMA
Serving The United States and Canada

CROUSE-HINDS EV Series

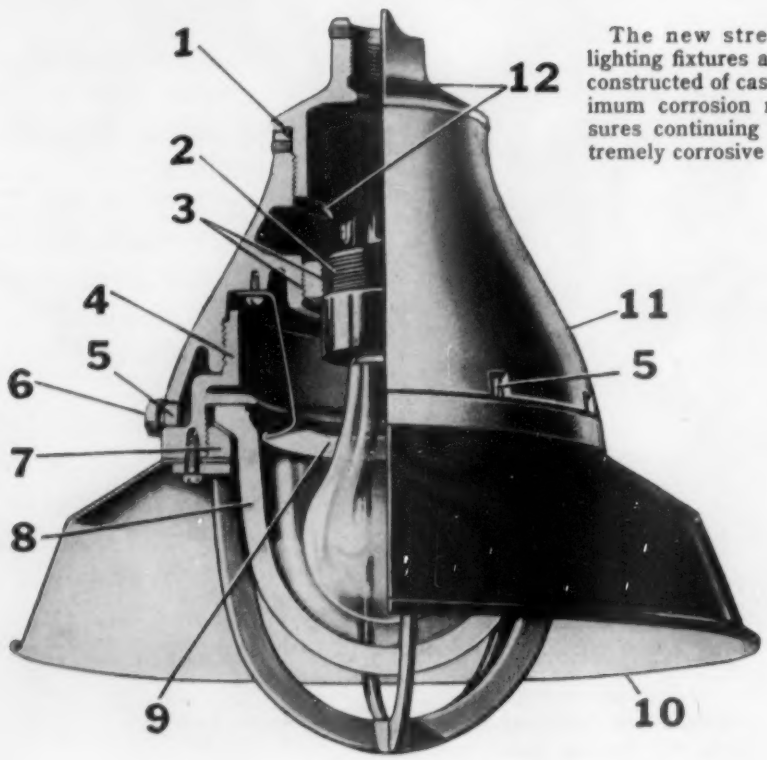
have been redesigned to give you:

EASIEST installation

EASIEST maintenance

HIGHEST efficiency

This adds up to big savings on every installation!

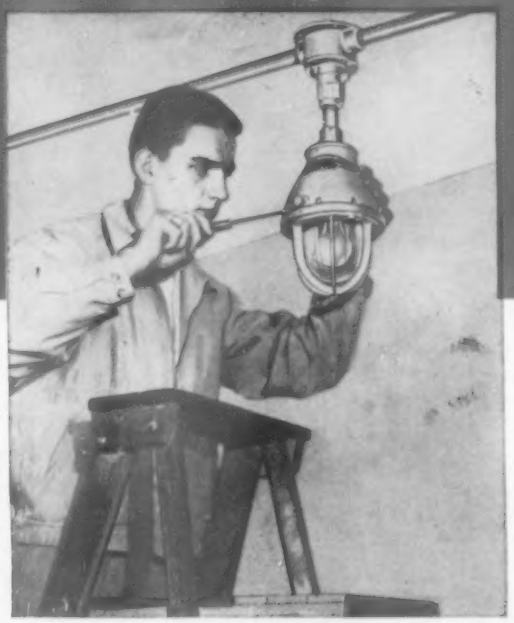


The new streamlined EV lighting fixtures are completely constructed of cast metal. Maximum corrosion resistance insures continuing safety in extremely corrosive locations.

1. Rubber O-ring gasket . . . seals joint against dirt or liquids.
2. New improved shock-absorbing receptacle has "universal" action . . . absorbs shock from *any* direction.
3. Threaded joints are flame tight . . . no sealing compound or external seals are required.
4. Lightweight one-piece assembly of globe, holder, guard and reflector is threaded high up inside of hood . . . no liquid or dirt can enter.
5. Notches in hood and globe holder . . . easy to loosen with a screwdriver.
6. Large knurled thumb screw . . . sets between notches for positive locking.
7. Globe retaining ring and cushioning gasket.
8. Heat and impact resisting globe. The accurately ground flange, essential for safety, is protected in a factory assembled joint . . . never exposed to damage.
9. Auxiliary reflector . . . etched Alzak aluminum . . . eliminates "trapped" light.
10. Porcelain enameled steel reflector.
11. Cast aluminum hood.
12. Cast aluminum body . . . has two openings for easier wiring from either side.

CONDULETS · AIRPORT LIGHTING

Explosion-Proof LIGHTING FIXTURES



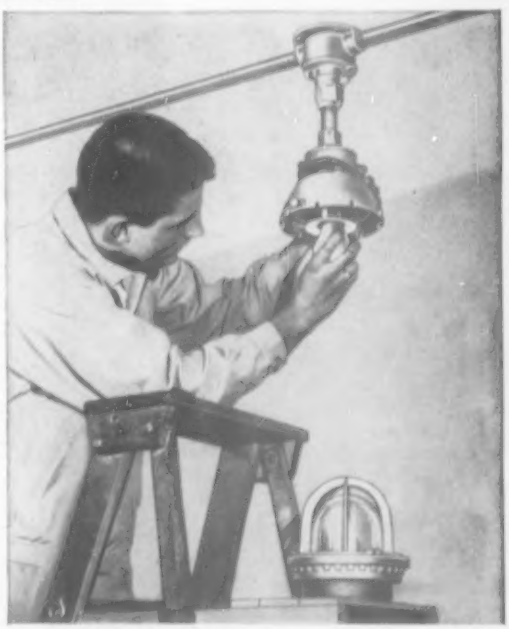
Easiest Relamping—3 Simple Steps

1. Single unit globe-holder assembly threaded into fixture hood is quickly removable for relamping. Slots are provided for prying with a screw-driver when necessary in corrosive atmospheres or other severe conditions. A large knurled thumb screw is easily loosened to unlock the globe and holder.

2. Globe and holder complete with guard (and reflector if used) is removed as an assembly. Only one lightweight piece to handle—globe retained in holder with flame-tight joint fully protected. Explosion-proof integrity assured. The 200/300-watt globe-holder assembly weighs but 8 lbs.

The new design of EV Explosion-Proof Lighting Fixtures is based on exhaustive studies and tests in Crouse-Hinds laboratories. The goal was to produce a fixture that would be easier to install and easier to relamp than any other explosion-proof fixture. Crouse-Hinds designers not only achieved this result but also created a fixture having the highest possible lighting efficiency.

You get 3-way savings when you install Crouse-Hinds EV Lighting Fixtures: quicker installation; quicker relamping; more light. This makes them the best buy for lighting in any location that is hazardous because of the possibility of the presence of flammable atmospheres. Use them on every job and have the best!



3. In relamping only a lamp is carried up and down the ladder and one assembly handled. It is not necessary to stock any spare parts or assemblies for complete convenience.

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver
Detroit — Houston — Indianapolis — Kansas City — Los Angles — Milwaukee — Minneapolis
New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore. — San Francisco — Seattle
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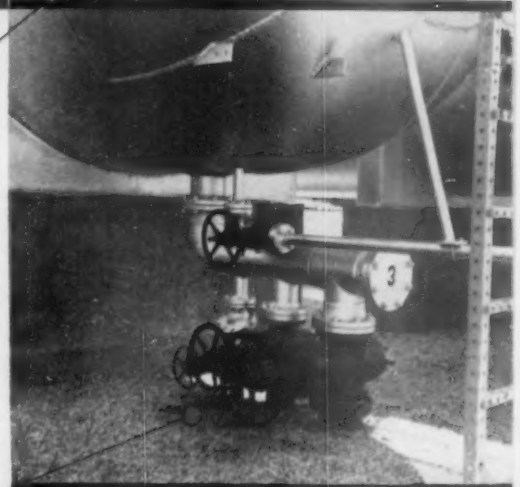
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

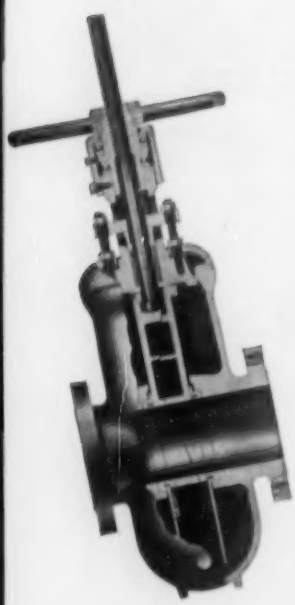
TRAFFIC SIGNALS · FLOODLIGHTS

W-K-M PROCESS VALVES FOR GASOLINE PLANT SERVICE

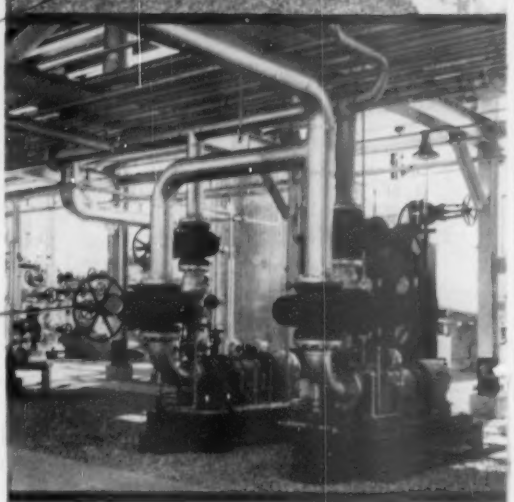
When you figure that W-K-M Process Valves have metal-to-metal seals to provide complete safety under any conditions, that they permit full pipe-diameter flow without turbulence, that positive opening and closing are guaranteed by W-K-M's exclusive Leverlock design, that they can be completely overhauled with very little trouble while on the line, that they are available in any trim for any process service—high pressure hot or low pressure cold—it is no wonder that more and more gasoline plants and refineries are specifying W-K-M for the key jobs—and some plants use them all the way through. Write for Bulletin 698 for the complete data about these valves or ask for a W-K-M sales engineer to call.



These valves and those shown below are in a gasoline plant in West Texas. Reading from left to right in above photo, the valves are in service on loading pumps handling butane, at 125 psi ga., 85° F; gasoline, 75 psi ga., 85° F; propane, 225 psi ga., 85° F.

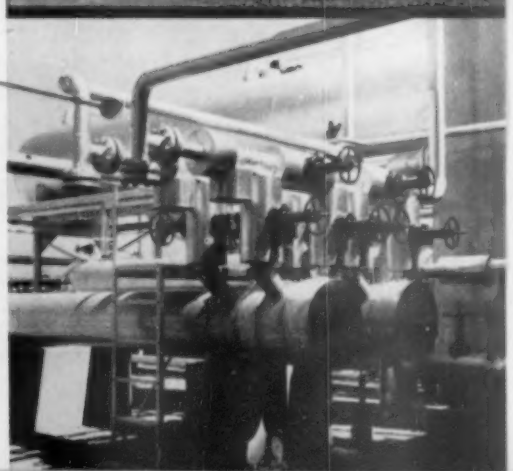


At left is cutaway section of the W-K-M Process Valve. Shown below is drawing of the exclusive W-K-M Leverlock mechanism which guarantees positive opening and closing under all conditions.



W-K-M Valves on butane stock tank at 125 psi, 80° F. Four valves are used on each tank and there are ten tanks.

These valves provide reflux to propane fractionator. They handle propane at 275 psi ga., 108° F.



These jacketed valves handle unstabilized gasoline at 550 psi ga., 260° F. in deethanizer feed exchanger.

W-K-M Valves

W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF A.C.F. INDUSTRIES INCORPORATED

P. O. Box 2117, Houston 1, Texas
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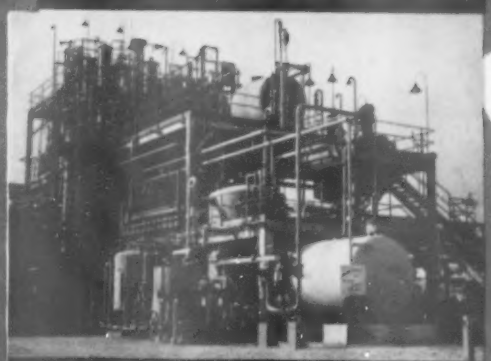
DROP FORGED STEEL

valves, fittings and flanges by Vogt

REFINERIES



CHEMICAL PLANTS

POWER PLANTS

USED and TRUSTED by the NATIONS KEY INDUSTRIES

There are good reasons behind the trust which America's key industries have placed in Vogt valves, fittings, and flanges for half a century. They know that *drop forged materials* are uniform in structure, fine grained, and free from porosity. They know, too, and appreciate the meticulous care given these products through every stage of forging and machining in Vogt's modern shops, and about the many rigid tests and inspections. And that is why these products enjoy such an impressive record of performance in withstanding the shocks and stresses imposed by high or low pressures and temperatures and in resistance to erosive and corrosive conditions.

Service is another important factor in this confidence because Vogt maintains the world's largest and most complete stock of drop forged steel valves, fittings, and flanges always ready for immediate shipment.

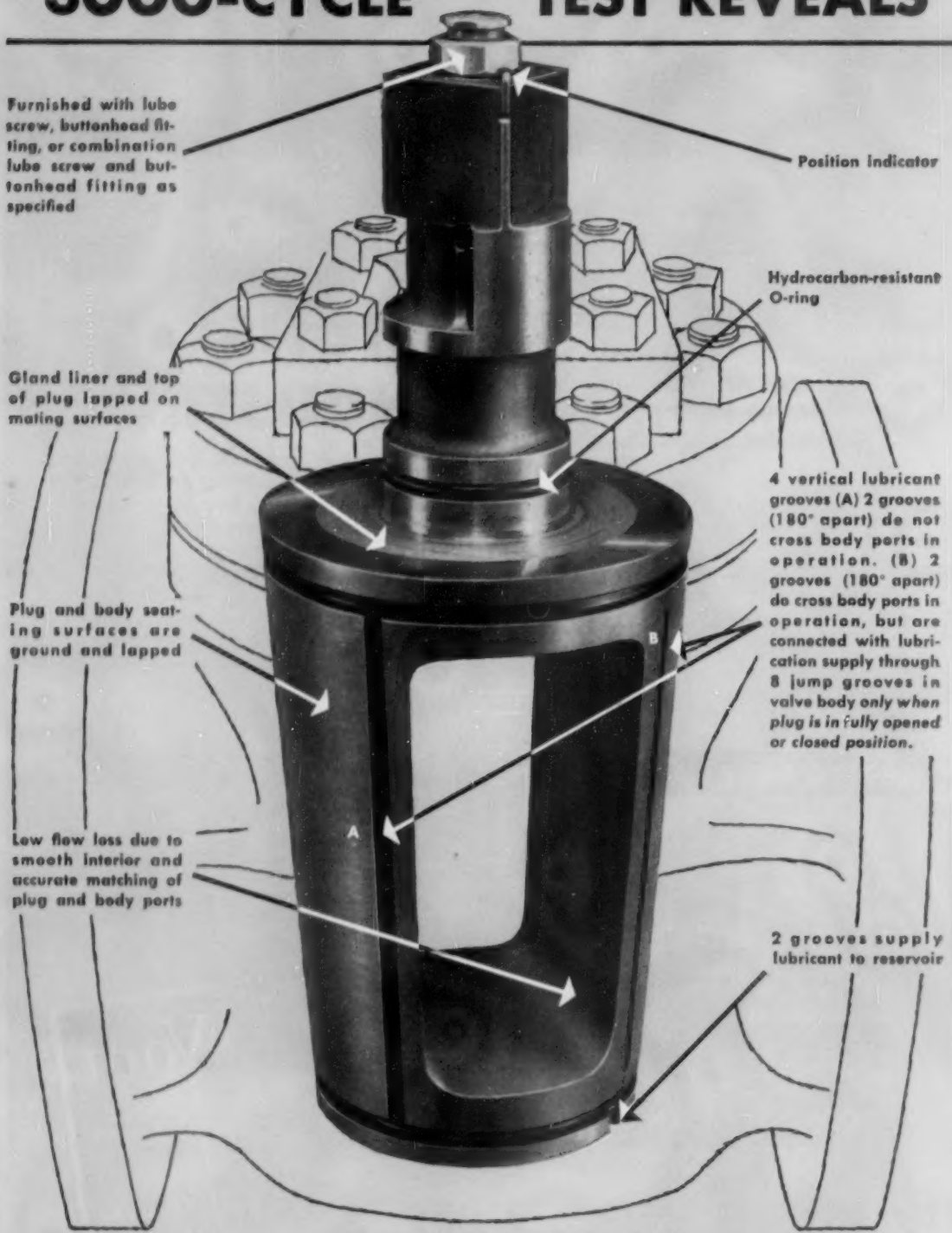
Write for Catalog F-9. Consult its 400 pages for the complete Vogt line of drop forged steel valves, fittings, and flanges for oil, steam, water, air, gas, and refrigeration services.

HENRY VOGT MACHINE CO. 75th Anniversary

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., San Francisco

3000-CYCLE TEST REVEALS


Furnished with lube screw, buttonhead fitting, or combination lube screw and buttonhead fitting as specified
Position indicator
Hydrocarbon-resistant O-ring
Gland liner and top of plug lapped on mating surfaces
4 vertical lubricant grooves (A) 2 grooves (180° apart) do not cross body ports in operation. (B) 2 grooves (180° apart) do cross body ports in operation, but are connected with lubrication supply through 8 jump grooves in valve body only when plug is in fully opened or closed position.
Plug and body seating surfaces are ground and lapped
Low flow loss due to smooth interior and accurate matching of plug and body ports
2 grooves supply lubricant to reservoir
A
B

WHY NEW OIC DESIGN EXTENDS PLUG VALVE LIFE

TEST: This 150-lb. steel valve cycle tested with solvent, 3000 full openings and closings at 425 p.s.i.

RESULT: Pressure tight . . . still operable at low torque . . . no sign of galling or seizing.

Gland assembly: Resilient packing completely isolated from rotating parts. Requires little adjustment and assures longest possible packing life.

The gland liner is OIC "Alloy 40", an aluminum-silicon-bronze having a melting point in excess of 1750 F. It has low friction bearing characteristics, will not seize or gall and affords an additional pressure seal between the plug and itself.

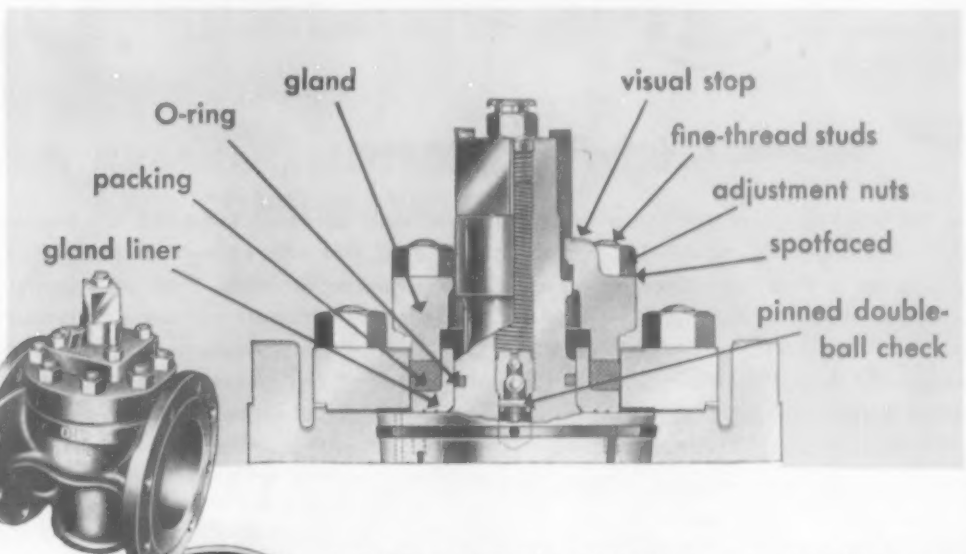
Precision gland adjustment: Fine-thread studs with semifinished, washer-faced nuts on spotfaced bearing surfaces afford accurate plug adjustment.

Position indicator on top of plug shank and *visual stop* on gland show position of plug at a glance.

Pinned double-ball check at bottom of plug shank eliminates blow-outs when lube screw or lube fitting is removed and precludes loss of balls into lubrication system under high-pressure gun lubrication.

Write today . . . request Form No. 1003, which will give you complete valve details, including specifications.

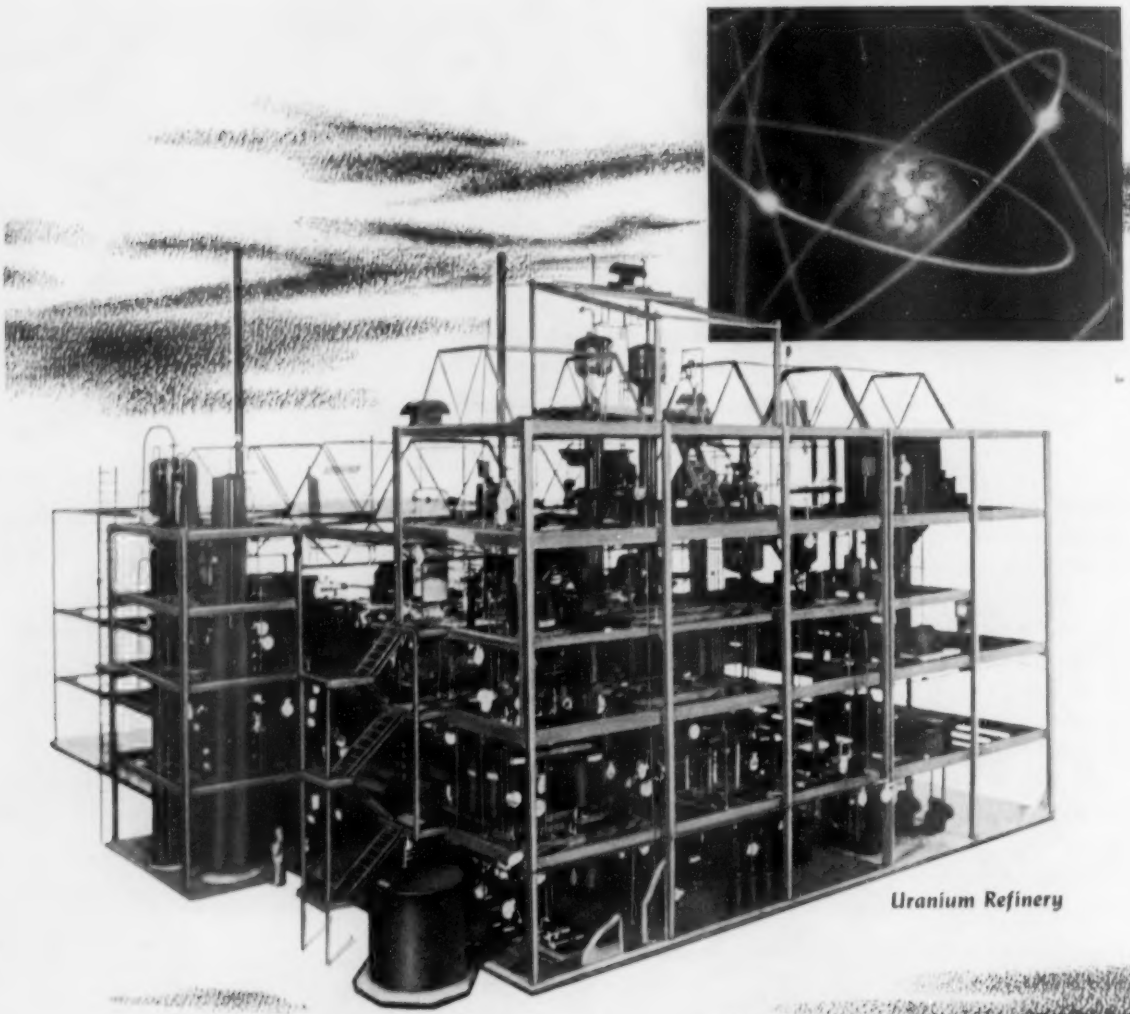
Order from your OIC Distributor



OIC

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | FORGED & CAST STEEL, IRON & BRONZE, LUBRICATED PLUG VALVES



Uranium Refinery

MODEL for Tomorrow

The full scale commercial uranium refining plant—of which this is a model—is now under construction at Port Hope, Ontario, and will be completed in 1955, the first of its kind in Canada. With engineering and construction by Catalytic, it will make available to Eldorado Mining and Refining, Limited (a Crown Company) the most advanced processes for uranium refining. This new example of our services in advancing uranium technology portrays Catalytic's position of leadership in the industry of tomorrow. We welcome your inquiries today —that Catalytic's on-time, on-budget services may contribute to your success of tomorrow.

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NOW – for Greater Safety!
Explosion-Proof...
Dust Tight...
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APPLETON Motor Starter UNILETS installed on jacket water and gas coolers, Engine Room No. 2, Main Line Booster Station of Permian Basin Gas Co., Spraberry, Texas.

APPLETON

CIRCUIT BREAKER, MOTOR STARTER AND COMBINATION UNILETS®

■ For safe, dependable performance in explosive atmospheres, select APPLETON Motor Starter and Circuit Breaker UNILETS with *absolute confidence.* Proof is industrial plant specification of APPLETON UNILETS *without substitution* for some of the nation's most important petroleum and chemical processing projects. APPLETON UNILETS provide dual safety... during operation and maintenance alike... which eliminates "down time" on other electrical operating equipment while servicing. In addition, you get initial and long term savings, long life, and simplicity of installation and wiring. For additional information, write today.

Sold Exclusively Through Selected Wholesalers

APPLETON ELECTRIC COMPANY
1718 Wellington Avenue • Chicago 13, Illinois

Advantages Found Only With APPLETON!

- **FIRST to be U. L. Approved for BANKED Circuit Breaker Grouping**
- **Combinations Meet U. L. Requirements through Approval of Components**
- **FIRST to Achieve Safe Entrance to Motor Starter of a Combination without Shutting Off Other Branch Circuits**
- **Full 7-Thread Explosion-Proof Protection... No Bolts to Strip or Flanges to Nick**
- **Unmatched Accessibility for Easiest Wiring and Servicing on Every Job**
- **Light-Weight Construction for Easy Installation without Heavy Lift Equipment**
- **Quick Interchange on Leading Makes of Circuit Breakers and Motor Starters**
- **Flexible Field Set-ups Assured with Single and Duplex Male and Female Hub Adapters**

PATENT PENDING

Write Today For Complete Information

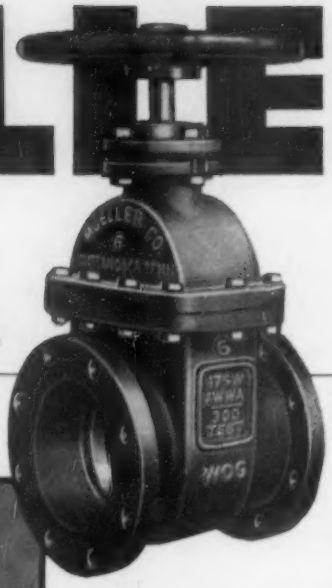
Also Manufacturers of:

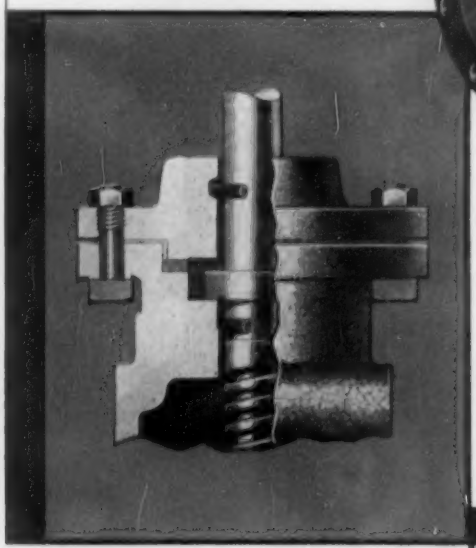
APPLETON ELECTRIC PRODUCTS

Rely on **APPLETON** *...the Standard for Better Wiring*

MUELLER®

gate valves





Permanent Seals

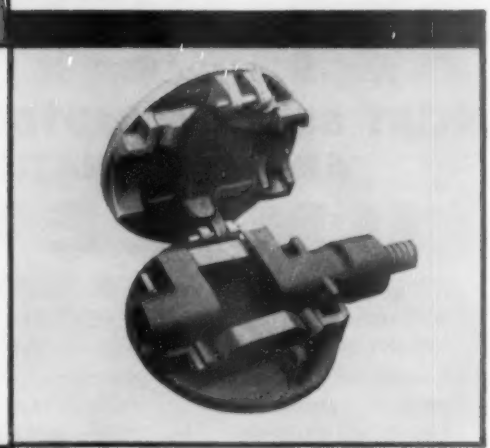
"O" Ring Seals in place of conventional stem packing gives permanent, leak-proof seals without retightening or repacking. An effective seal is assured because an increase in pressure increases the sealing force.

Periodic lubrication is eliminated, too. The space between the upper "O" ring dirt seal and the lower "O" ring pressure seal is filled with a special lubricant.

Positive Shut-offs

The only gate assembly with the exclusive "four-point-contact" disc wedging mechanism. Closing pressure is equally distributed to four separate points *near the outer edge* of each disc—no disc deflection!

Double, parallel discs have right angle movement when valve is opened or closed. Discs seat flat against seat rings without sliding or scraping—no worn parts!



Check your service needs today and consult your Mueller Representative or write direct for full details.

NO-BLO

MUELLER CO.

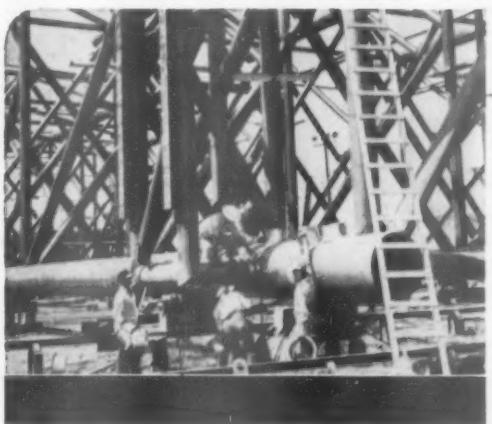
Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

Avondale...

now 4 divisions

serving the Oil Industry



What with the ever increasing off-shore oil activity, the 4 divisions of Avondale become relatively more important as services to the Oil Industry! In truth, the 4 divisions comprise a team to serve the Oil Industry—every phase of it, from production to refining. Service Foundry Division—casting, gear cutting, machine work. Harvey "Quick Repair Plant"—drydocking, expert propeller service. Main Yard—steel fabricating, ship, barge, towboat building, and repairs. Avoncraft Division—Porcelain Enamel Service Stations.

SERVICE • INTEGRITY • EFFICIENCY

SHIP BUILDING • SHIP REPAIRING • FOUNDERS • PROPELLERS • STRUCTURAL STEEL

AVONDALE MARINE WAYS, INC. CABLE ADDRESS "AVONWAYS"

P. O. BOX 1030 • PHONE UNiversity 4561 • NEW ORLEANS 8, U. S. A.

HUSKY'S RESULTS

The Charge		The Product	
API	52.6	API	62.8
Sulfur %	0.1	Sulfur %	0.001
RVP	8.1	RVP	12.0
ASTM Over	85	ASTM Over	87
End Pt.	370	End Pt.	385
CFRR Octane Clear	54.0	CFRR Octane Clear	80.8
		3cc	94.8
		C4 Plus Yield, Vol. %	95.5

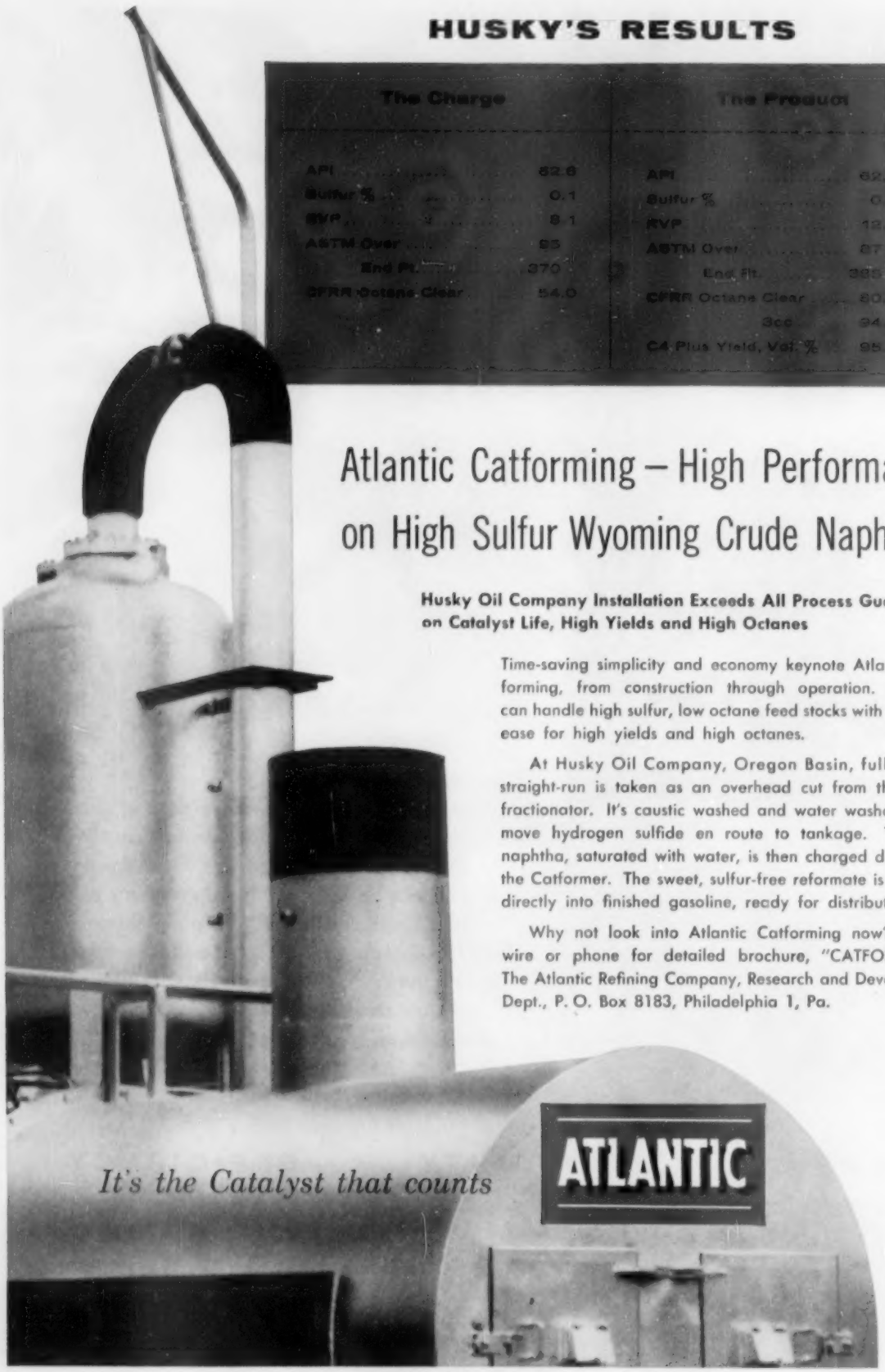
Atlantic Catforming – High Performance on High Sulfur Wyoming Crude Naphthas

Husky Oil Company Installation Exceeds All Process Guarantees on Catalyst Life, High Yields and High Octanes

Time-saving simplicity and economy keynote Atlantic Catforming, from construction through operation. Refiners can handle high sulfur, low octane feed stocks with one-step ease for high yields and high octanes.

At Husky Oil Company, Oregon Basin, full-boiling straight-run is taken as an overhead cut from the crude fractionator. It's caustic washed and water washed to remove hydrogen sulfide en route to tankage. This raw naphtha, saturated with water, is then charged directly to the Catformer. The sweet, sulfur-free reformate is blended directly into finished gasoline, ready for distribution.

Why not look into Atlantic Catforming now? Write, wire or phone for detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8183, Philadelphia 1, Pa.



It's the Catalyst that counts

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

POWELL VALVES FOR MODERN INDUSTRY

FIG. 2193—Ni-Resist* Gate Valve for 200 Pounds W.O.G.

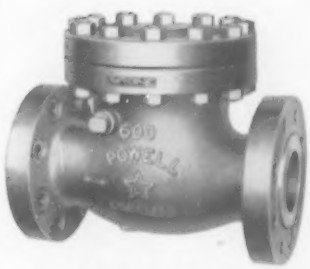
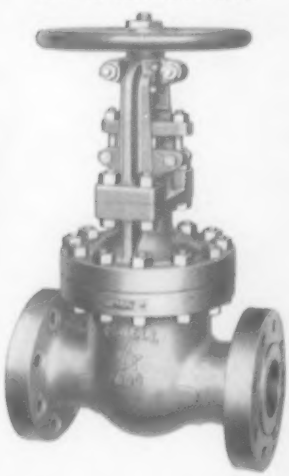


FIG. 6061 SS—600 Pound Stainless Steel Swing Check Valve

FIG. 6003 SS—Alloy Steel Gate Valve for 600 Pounds W.S.P.



*Trademark of The International Nickel Co.

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

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. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

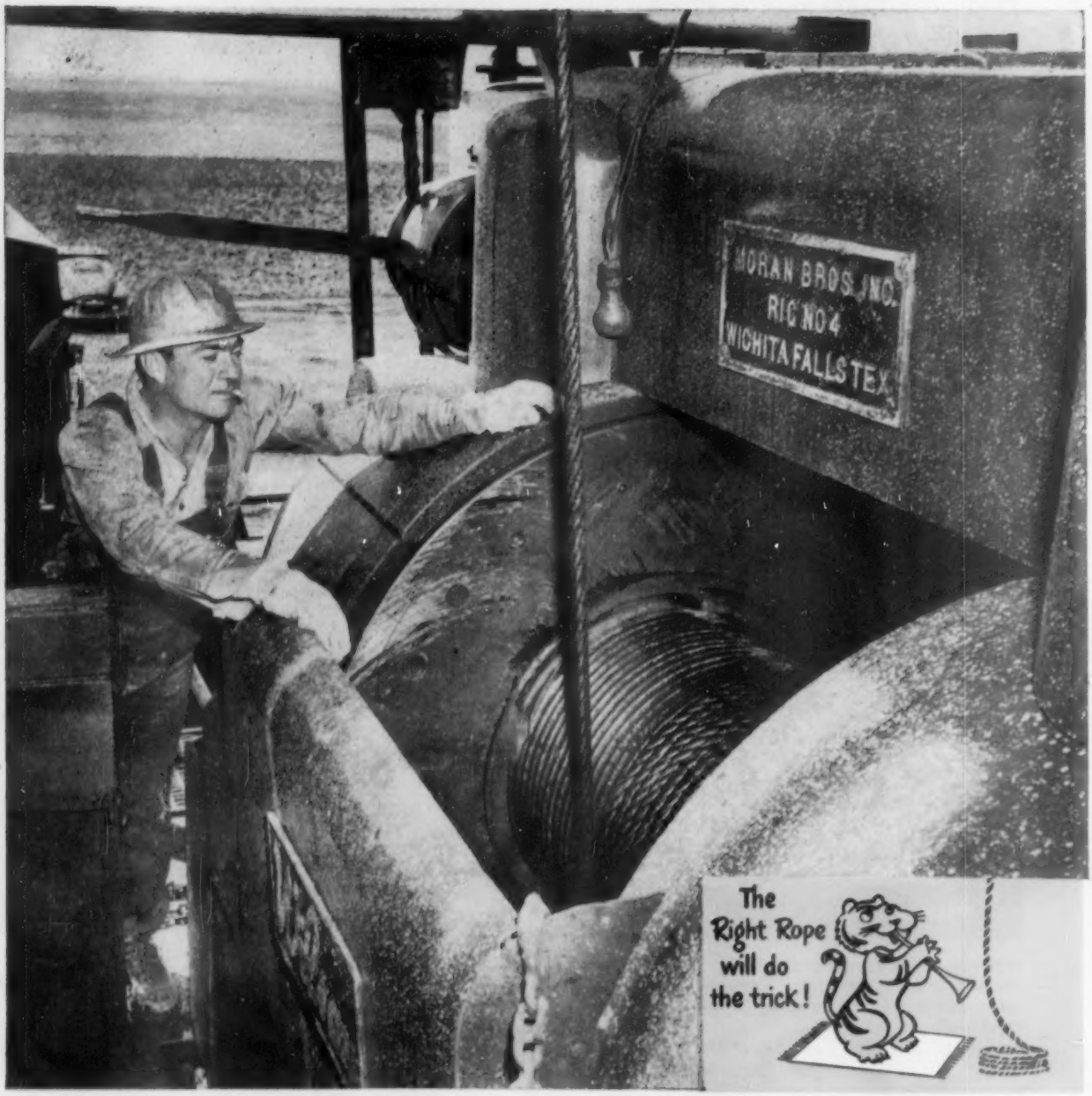
When you think of valves—think of Powell. For Powell has a *complete* quality line. Powell probably makes more kinds of valves and has solved more valve problems than any other organization in the world.

Shown above are just a few Powell Valves. Investigate these valves . . . *and* the *complete* line of quality valves made of bronze, iron, steel, special alloys and pure metals.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

"We won't use anything but for drilling lines and



Tiger Brand winch lines"

says **Mr. R. J. Moran,** *Vice President*
Moran Brothers, Inc.,
Wichita Falls, Texas

MORAN BROTHERS INC. have drilled oil wells all over the Southwest. They have learned how to drill a well on contract—*at a profit.* And they've learned that their best buy in wire line is Tiger Brand. Here's what R. J. Moran told us:

"We find that Tiger Brand Line *costs us less* than any other make we've tried—regardless of price. That's because Tiger Brand lasts longer and gives us the best ton mileage.

"Right now, we're averaging about 11.2 ton miles per foot of hole *without even lubricating the lines.* We just don't have time for maintenance with our rigs running constantly. Once a line is installed it doesn't get touched till it's replaced. Tiger Brand works so well under these conditions that we use it on *all* our rigs—both rotary and cable tool—and also on our winch trucks."

Praise like this for Tiger Brand is an old story. Time after time you hear, "Tiger Brand gives exceptional service." "Our line costs are extremely low."

Prove it to yourself. Send the coupon for one of our free Ton Mile Calculators. Then rig up with Tiger Brand and check its performance *on your own rig.* We're sure you'll be back for more Tiger Brand Line.

MAIL THIS COUPON

American Steel & Wire
Room P-35, Rockefeller Building
Cleveland 13, Ohio

☐ Rush me one free Tiger Brand Ton Mile Calculator.

☐ Have your representative call to show me how this calculator can help me cut line costs.

Name .....

Firm .....

Address .....

City & State .....

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION
GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

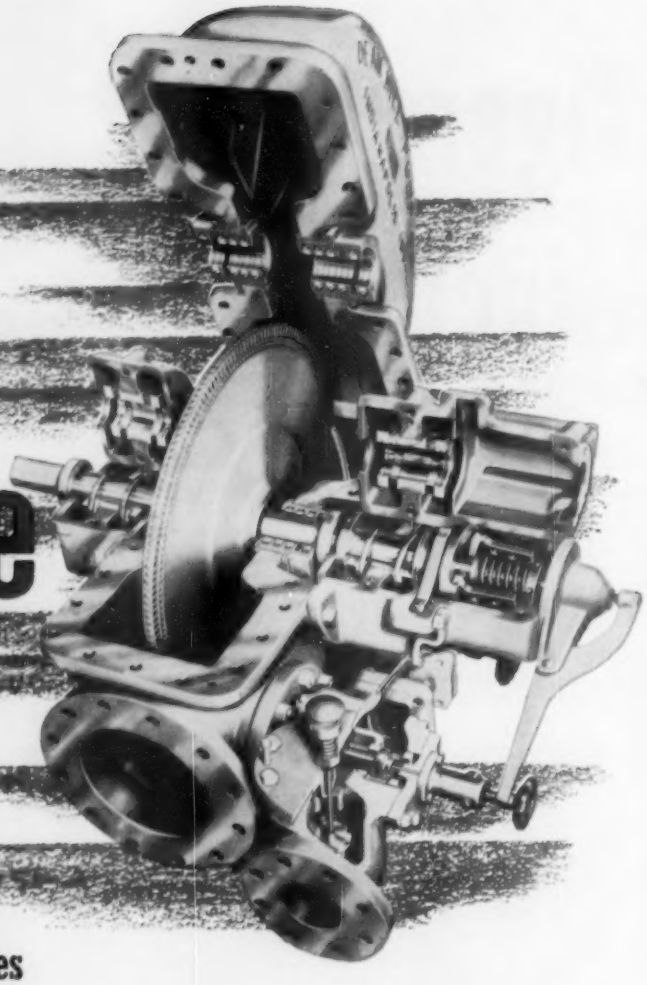
USS AMERICAN TIGER BRAND WIRE ROPE

Excellay Preformed

USS

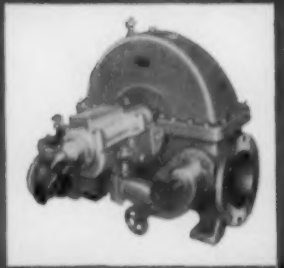
UNITED STATES STEEL

up to 100% more power



added to DH turbines

More power from the same size unit! Dean Hill presents an improved DH Line of horizontal turbines which produce up to twice the power of former counterparts.



The major change contributing to this tremendous power increase is the addition of one or more steam nozzles to all models, with these results . . .

1. The new, two-nozzle DH-10 and DH-20 turbines have double the maximum horsepower of former units.

2. Models DH-30, DH-40 and DH-45, now with three nozzles, are rated 50% higher in maximum horsepower.

FULL INFORMATION AVAILABLE

Many other improvements have been made on the five DH Models, adding to the quality and performance of Dean Hill Horizontal Turbines. A new catalog completely describes these models, and this information will be sent you on request.

Write Today For Dean Hill's New Turbine Catalog No. 500.

DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893

Indianapolis 7, Indiana

Sales Offices in

Chicago, New York, San Francisco, Bartlesville, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, [illegible]

WHEN PRESSURE IS PARAMOUNT

Tube Selection Cannot Be Reduced to a Formula—Even a Complicated One

The choice of the optimum tubing to use in an application requiring the handling of a specific fluid at a definite working pressure involves the consideration of a number of factors. In addition to temperature, tube size, and mechanical strength of the steel, such factors as the type of fluid and corrosion resistance of the steel must be considered.

A typical case of the importance of these two factors involved an installation of Type 347 stainless steel. The tubing was exposed to chloride-bearing bayou water while conveying methanol and unreacted synthesis gases at 300F and 5000 psi. The chloride solution caused pitting corrosion. The stresses became localized at the root of the pits and reached a sufficient magnitude to cause stress corrosion and failure. Croloy 5, subsequently used, provided superior resistance to the initial pitting and satisfactory service at the desired temperature and working pressure and also at a considerable savings in cost of the tubing.

It takes an expert to specify the optimum tubing for any particular application. And there is no substitute for the kind of experience with such problems you'll find at B&W. To get the most benefit from B&W's long experience in matching tubes to jobs call on Mr. Tubes, your nearby B&W Tube Representative. He can help you.

TA-4024 (P)

Custom-

to give you

"More than just a Truck-"

The very concept and design of FWD—the *original* four wheel drive truck—correctly proportions power to weight on all wheels, puts the power where there's work to be done. There is no better answer to your heavy duty problems because FWD is the truck that starts where others stop. FWD gets jobs done where conventional trucks can't even travel. Bring your heavy duty problem to FWD for a custom-engineered answer. You'll be talking to a Four Wheel Drive specialist.

FWD

MATH ◎ MATIC DESIGN

More Driving Power

Less Dead Weight thru Lighter Alloys

Greater Load-Carrying Capacity

Gets to More Jobs . . . Gets More Jobs Done

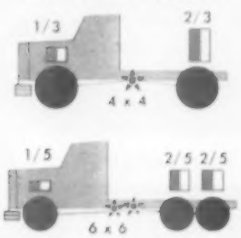
Greater Controllable Traction

Improved . . . and Proved Driving Safety

THE FOUR WHEEL DRIVE AUTO COMPANY

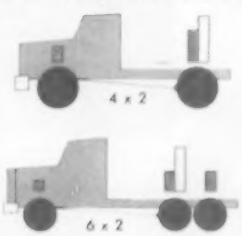
Engineered

FWD WITH ADVANCED MATH-MATIC DESIGN



Note how power is correctly proportioned to weight distribution.

ORDINARY REAR-WHEEL-DRIVE TRUCKS



Note how power is wastefully concentrated on one axle.

P Proportion of power on each axle ■ Proportion of weight on each axle

Advanced Math-Matic Design—in every feature of FWD—correctly proportions power to weight on front and rear axles . . . making every pound of load help haul itself! Each wheel's load adds driving power, turning every ounce of torque into more controllable traction, greater steering safety. *WRITE OR CALL for (1) your free copy of illustrated product folders in weight categories from 14,500 to 60,000 lbs. GVW. (2) your copy of "The Truck That Went to College"—scientific proof of four wheel drive superiority.*

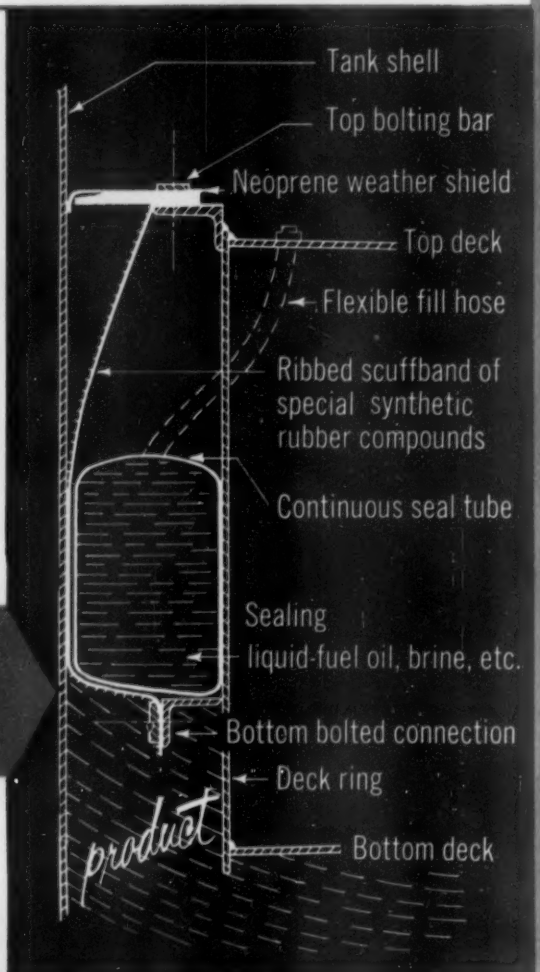
BUILDERS OF AMERICA'S FOREMOST HEAVY-DUTY TRUCKS

FWD MATH-MATIC DESIGN

CLINTONVILLE, WISCONSIN • *Canadian Factory,* **KITCHENER, ONTARIO**

Think of what this means to operators of FLOATING ROOF TANKS!

Elimination of potential vapor-loss and preservation of product quality, the most important reasons for a floating roof tank, are now reality . . . the **HAMMOND TUBESEAL,*** for floating roof tanks of welded or riveted construction, provides the most efficient and positive seal known . . . sealed at a point to prevent vapor space between roof, rim and shell, thus there is no room for vapors to form or for the product to come in contact with outside influences and be contaminated . . . the **TUBESEAL*** has no moving parts, requires no maintenance, adjusts for tank out-of-roundness, is climate proof and non-corrodible, can operate to bottom of tank or above the top . . . **ITS ENTIRE CIRCUMFERENCE IS TIGHTLY SEALED UNDER PRESSURE AT ALL TIMES . . . NO VAPOR SPACE BELOW THE SEAL.**



THERE'S NO ROOM FOR VAPORS TO FORM WITH THE HAMMOND TUBESEAL

THE **HAMMOND TUBESEAL*** HAS BEEN THOROUGHLY TESTED IN COMMERCIAL USE . . . IT IS **GUARANTEED** TO YOUR SATISFACTION.

*Copyright

ask for Bulletin TS

HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

CHEAPER OVER THE YEARS

HAMMOND IRON WORKS

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CASPER, WYO. • BIRMINGHAM, ALA.

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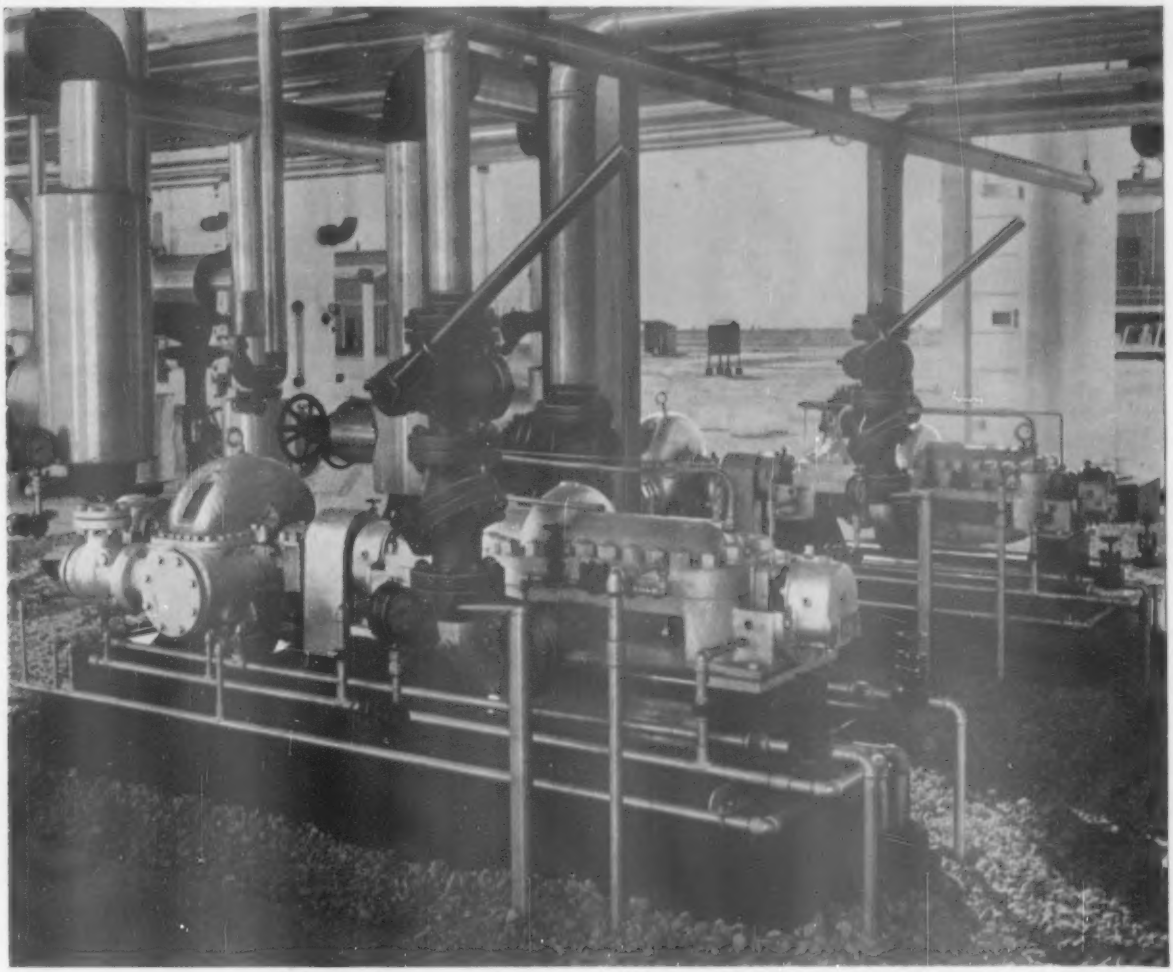
on deethanizer feed at PEGASUS PLANT



Ingersoll-Rand Pumps are giving efficient and dependable service at the Pegasus Plant in West Texas, operated by Magnolia Petroleum Company and built by Hudson Engineering Corporation. The two 2CNTA 8-stage steam-turbine-driven units shown above are on deethanizer feed service, handling 202 gpm of unstabilized gasoline of 0.515 specific gravity at 90°F. Suction pressure is 90 lbs. and developed head, 2155 ft. at 3500 rpm. Multi-stage Class CNTA pumps, with easily removable unit-type rotor assembly, are exceptionally well suited to refinery service involving pressures from 100 to 800 lb. and capacities from 50 to 700 gpm.

Other Ingersoll-Rand centrifugal pumps in continuous operation at the Pegasus Plant include many different units in a wide range of types, sizes and applications.

Consult with the I-R branch office near you for the solution of all your liquid moving problems.

Ingersoll-Rand

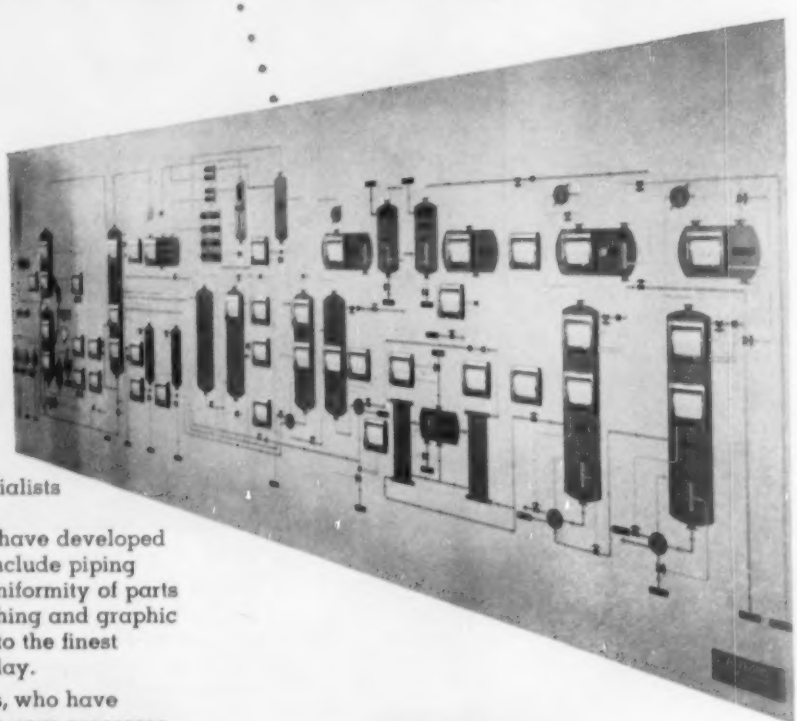
Cameron Pump Division

11 Broadway, New York 4, N. Y.

10-93

PUMPS • COMPRESSORS • TURBO-BLOWERS • VACUUM EQUIPMENT • AIR & ELECTRIC TOOLS • GAS & DIESEL ENGINES

engineered GRAPHIC PANELS by FOXBORO



Working as a team, Foxboro Panel and Process Control Engineers offer you an unequalled resource . . . one which will assure you of the most efficient instrumentation, and the most practical panel layout, for your process.

Foxboro Panel Engineers are specialists in panel design and fabrication. Exclusive techniques which they have developed over many years of experience include piping arrangements, wiring methods, uniformity of parts and accessories, methods of finishing and graphic portrayal — all of which add up to the finest graphic panel work available today.

Foxboro Process Control Engineers, who have specified the right instruments for your processes over the years, are applying this valuable experience to the integrated control systems which you require today.

Whether we originate the graphic layout from your flow sheet, or work directly from a design of your own, this engineering teamwork will provide you with the ultimate in an operating panel for centralized process control.

If you are planning a new or modernized control room, let us detail a proposal for you, with comprehensive data on Foxboro Graphic Panels.

The Foxboro Company, 603 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO
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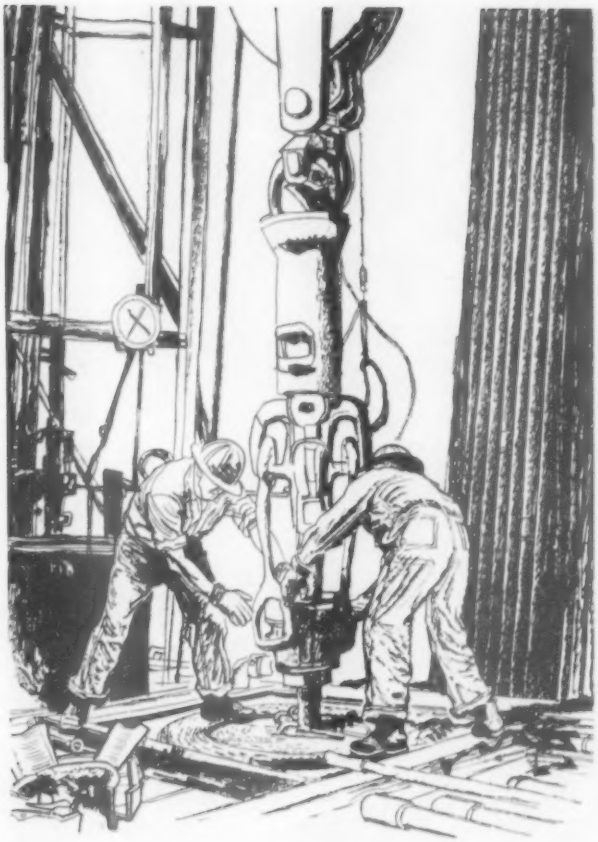
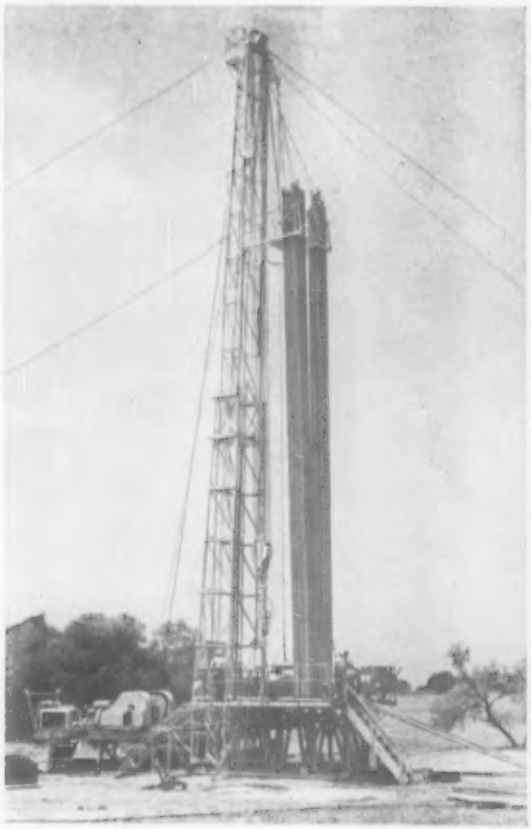
PROCESS CONTROL ENGINEERING

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND





Smooth as Steam

"SAVING $1.00 PER FOOT OF HOLE"

Contract driller H. V. Middleton's two TORQMATIC-equipped Franks "Comet" rigs have drilled about 130,000 feet of hole to date.

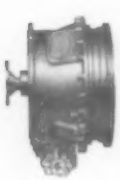
"My whole operation's both faster and cheaper now," the veteran wildcatter reports. With Allison TORQMATIC Converters delivering smooth, *shock-free* power to draw works and rotaries, maintenance costs are way down. The Converters haven't cost one cent for repairs. In fact, *all* repairs are fewer.

"I figure I'm saving about $1.00 per foot of hole over my previous rigs," Middleton reports.

That includes a 25% saving in the cost of moving his rigs. On a recent job—a typical one—he set up in 16 hours; tore down in 8. His saving on the 35-mile move: $4,000 over older type rigs.

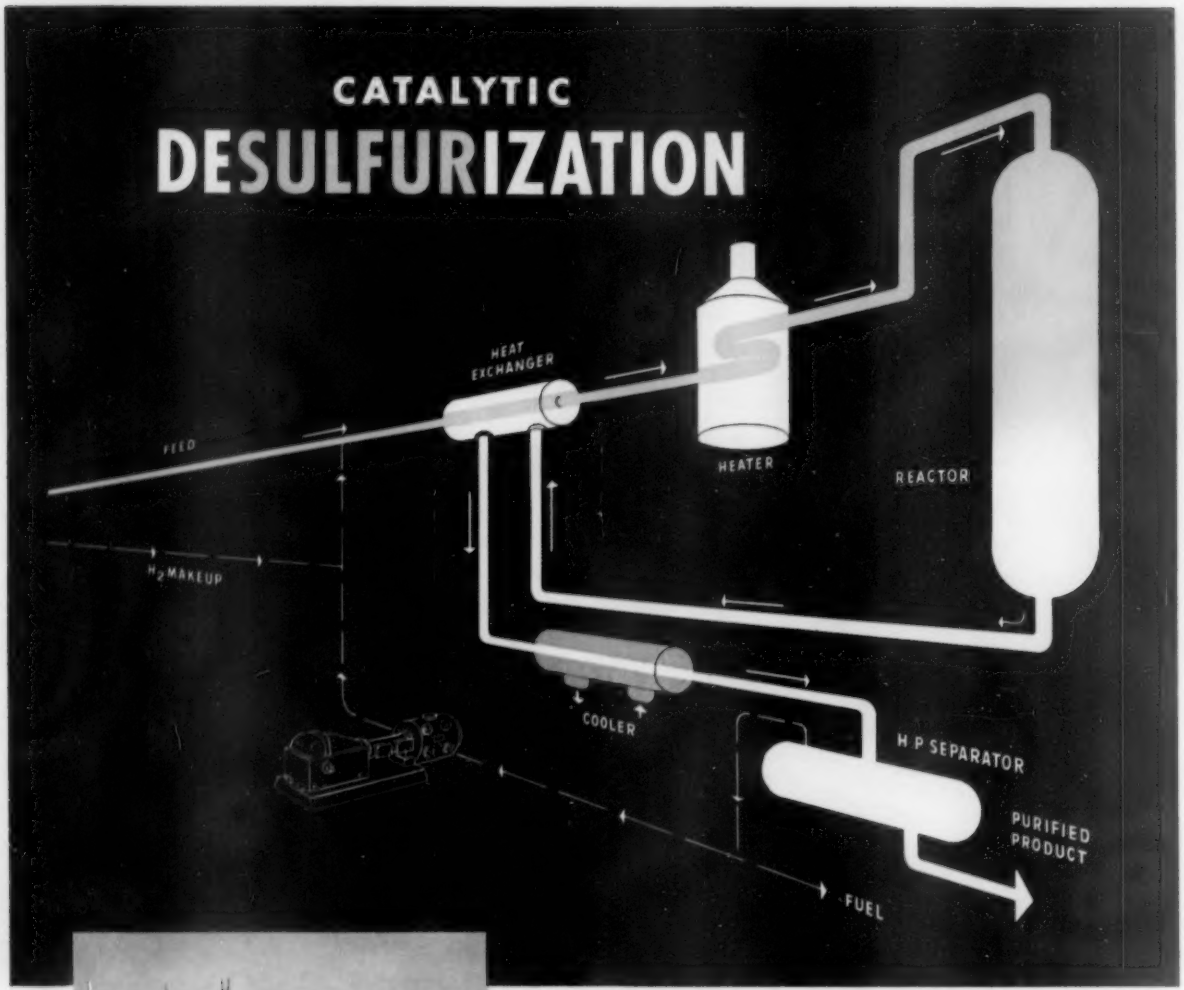
What's more, Middleton has found quick-responding TORQMATIC operation ideal for fishing. The ability to control a move of just one or two inches means far less chance of "losing the fish." And in regular drilling, there's far less chance of "twist-offs."

You can get Allison TORQMATIC DRIVES in drilling, servicing and fracturing equipment made by most leading manufacturers—or as replacement units for your present rigs. For the rest of the story, check your dealer, equipment manufacturer—or write to Allison Division of General Motors, Box 894R, Indianapolis 6, Indiana.



GM TORQMATIC Allison TORQMATIC DRIVES

CATALYTIC DESULFURIZATION



One of two catalytic desulfurization units designed and constructed by Foster Wheeler for a large European refinery. Three other units are now being installed by Foster Wheeler for a large Eastern refiner.

improves product purity
well below sulfur specifications
at low overall cost

Here's a practical solution to the problem of sulfur contamination in refinery products — especially troublesome when processing high-sulfur crudes.

Where by-product hydrogen is available, catalytic desulfurization will prove a highly profitable investment. Even if hydrogen must be generated for this purpose, the improvement in sulfur content, color stability, carbon residue and odor justify the installation on a sound economic basis.

Foster Wheeler know-how is at your service.

For full technical details of this process, send for the Feb. 1955 issue of "Heat Engineering".
Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

FOSTER WHEELER

ALL 3 OF THE "MOST WANTED" NEEDLE VALVE FEATURES

LUNKENHEIMER *Quarter-inch* BRONZE NEEDLE VALVES

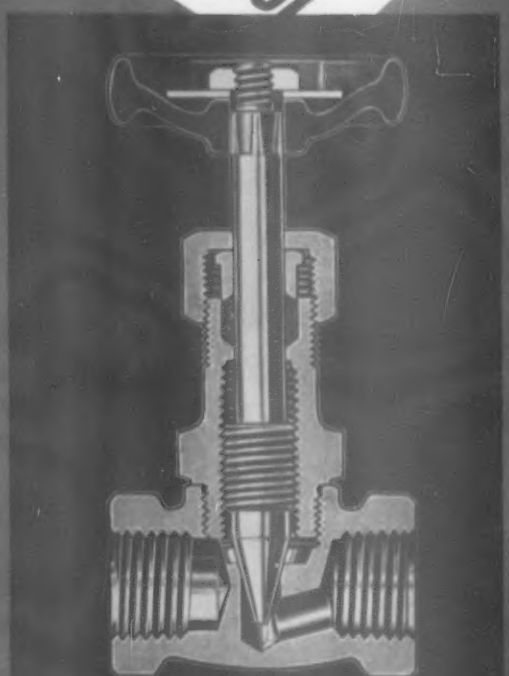
The internal body pattern is *machined* from a solid block of high-density cast bronze. This extra-dense body gives you the advantage of compact size and much greater strength.

With each cubic inch at a premium behind instrument panels, Lunkenheimer Quarter-Inch Needle Valves offer a space saving of 20%! They are only 2¾ inches high and 1½ inches wide.

Exceptionally close tolerances and fine stem-thread pitch assure absolute accuracy of flow control. Stems are available in your choice of cadmium-plated steel or Stemalloy,® the exclusive Lunkenheimer silicon-bronze alloy that never wears out. Of the millions of Stemalloy stems in service, not one has ever been returned due to wear failure.

BRONZE • IRON • STEEL • PVC

The cost of a Lunkenheimer Valve gets smaller and smaller and smaller with each passing year of dependable service.



Lunkenheimer Needle Valves are available in a wide variety of bronze and bar-stock steel types and in sizes from ¼" to 1", rated at 200 lb. S.P. and 400 lb. W.O.G. to 3000 lb. W.O.G. All patterns have gland followers and fine thread pitch. For more information, ask your Lunkenheimer Distributor for Circular 568, or write to The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.

L-255-17

QUALITY

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

You can do it CHEAPER with

UTILITY *Electric Power*

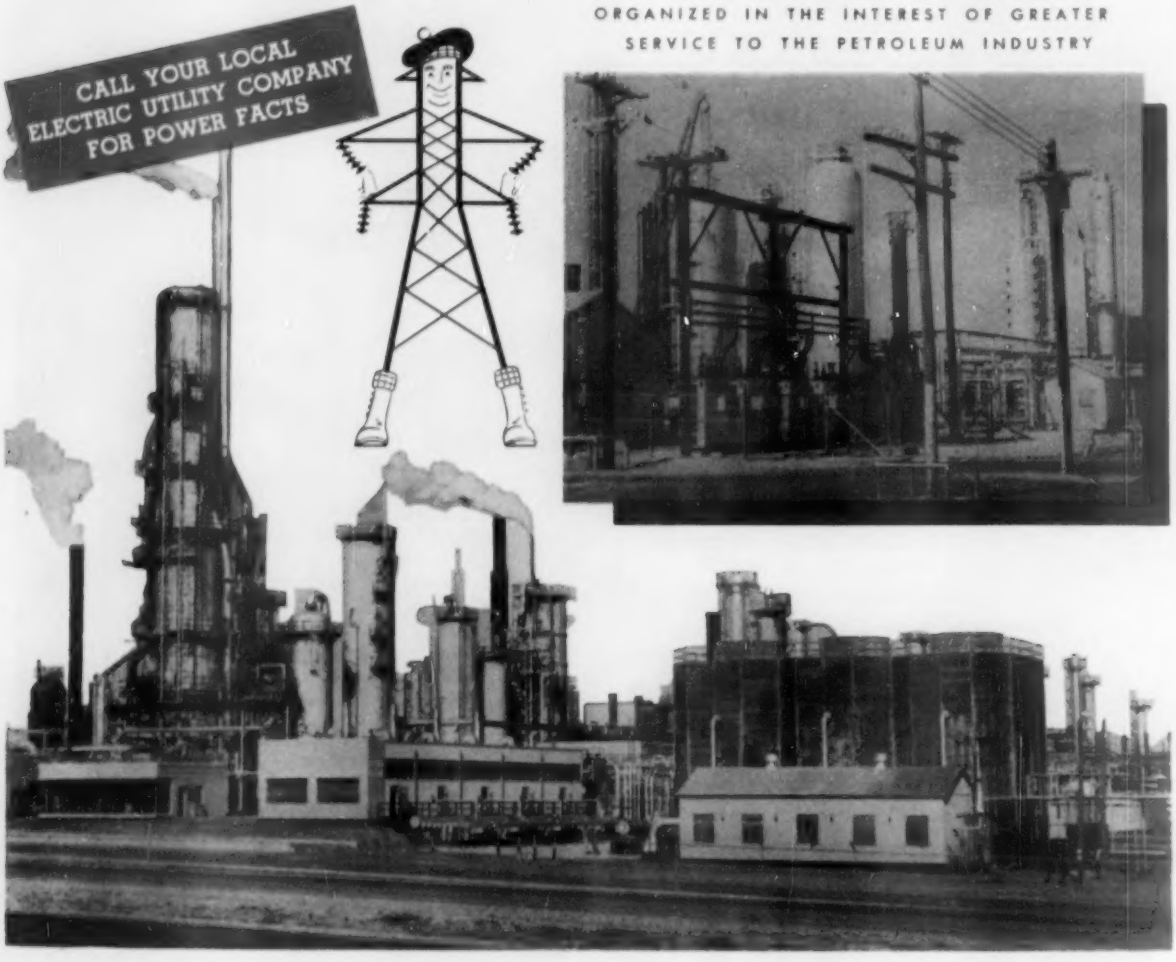
Refineries. Petrochemical Plants. Field Processing Plants - they all use Utility Electric Power

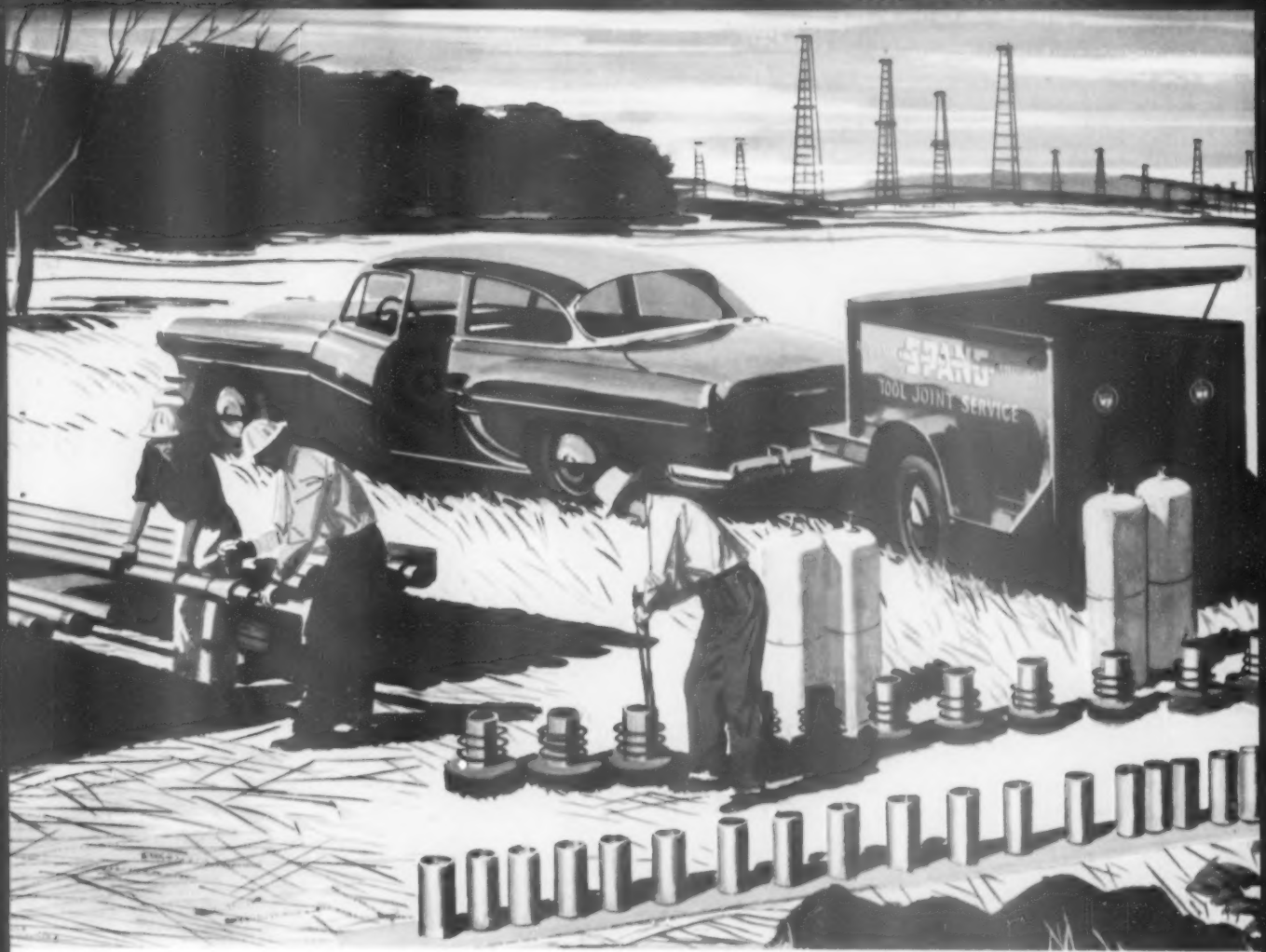
because Electric Power is flexible . . . compact . . . dependable . . . safe . . . clean . . . and can be installed at a Low Capital Investment, with LOW COST operational advantages, plus many other money saving features, including convenient automatic control.

Petroleum Electric Power Association

P. O. BOX 2771, DALLAS, TEXAS

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY





No delays for tool joint replacements at this rig!

. . . or at any other rig where this National tool joint serviceman stops with his specially-designed "furnace trailer" behind the familiar blue car. The trailer carries the 11 ring-type furnaces and four 100-lb. propane gas tanks you see here—along with wrenches, buffers and other equipment needed for shrink-fit tool joint replacement jobs.

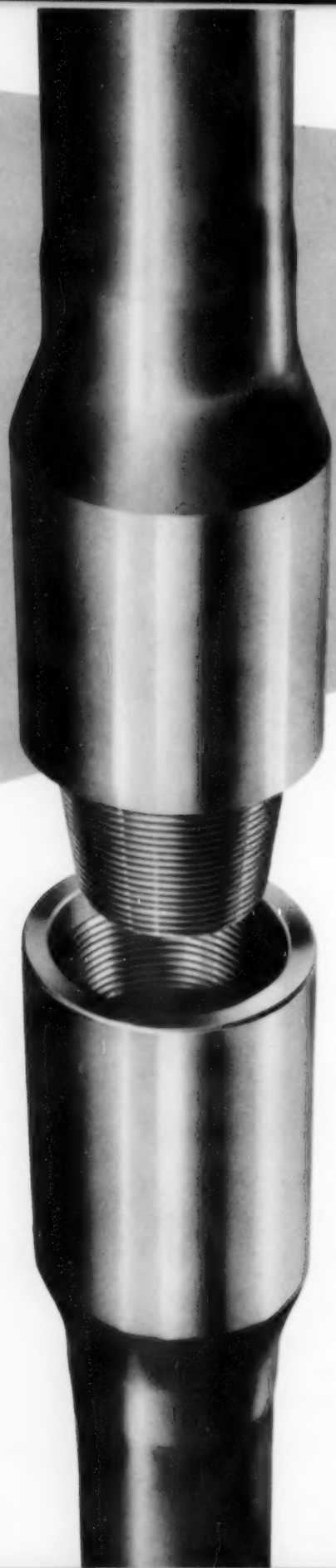
With the help of a few crew members, the trailer is unloaded, the equipment is readied—and the job goes fast. Worn-out tool joints are removed with an oxy-acetylene torch and the pipe ends are cleaned. The new joints, furnace-heated to the proper temperature in less than five minutes, are then readily applied. In a recent job with this trailer, 100 new 5-in. tool joints were applied to 3½-in. drill pipe in 8 hours!

Drilling contractors, of course, like the benefits of this on-the-job service. Because the replacement work can be scheduled for times when the pipe isn't in use, no delays are involved. And the costs of shipping pipe to a central shop for changes are completely avoided.

This furnace trailer is typical of National's many special field services—all of which are marked by an active, helpful interest that extends beyond the sale and continues to build profits for customers. You'll find this interest wherever and whenever you do business with National Supply.

First in quality...First in supply service in oil country everywhere

THE NATIONAL SUPPLY COMPANY



you can *REDUCE LEAKAGE, FATIGUE TENSION AND CORROSION FAILURES* with high quality

SPANGWELD

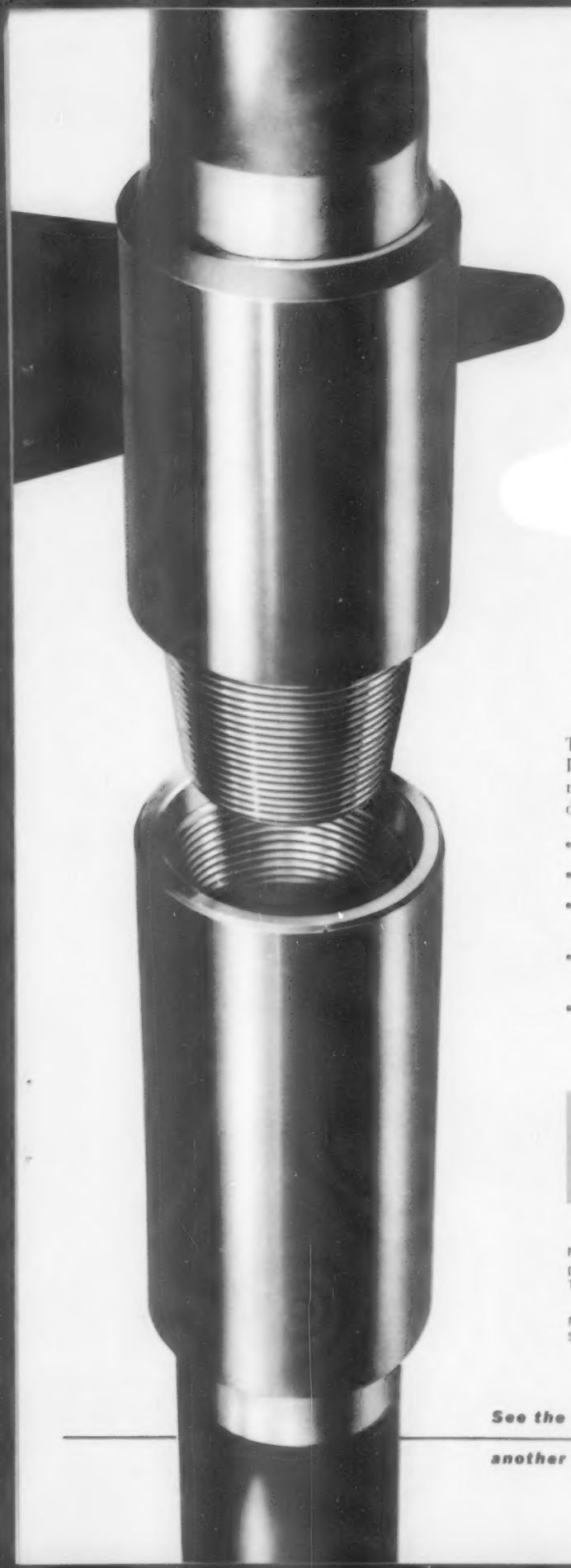
DRILL PIPE

Here's a drill pipe to meet the severe tests of modern deep well operations—and it's chosen by oil men for these outstanding advantages.

- Economy provided by welded connections which eliminate thread contamination and reduce fatigue failures.
- Reduced threaded connections—taper joint only is threaded.
- High strength welds of high quality, uniformity and strength.
- Abrasion resistance—hard-faced joints are available.
- Streamlined contour.
- Full size range—all common sizes and types, plus minimum diameter ratios for slim hole operations.

for maximum corrosion resistance

you can specify a multiple coat, baked phenolic plastic coating applied at the mill on Spang drill pipe. Ask the National Supply Representative about this Spang service—and any other information you'd like to have about this quality drill pipe.



SPANG®

double seal

shrink thread

DRILL PIPE

The precision metal-to-metal seal in the Spang Double Seal Shrink Thread Drill Pipe joint is the major reason for these advantages reported by drillers:

- Elimination of last engaged thread failure.
- No creepage during drilling.
- Prevention of fluid entry into threads with an external seal.
- Elimination of leakage and washout with an internal seal.
- Rapid replacement of tool joints right at the rig.

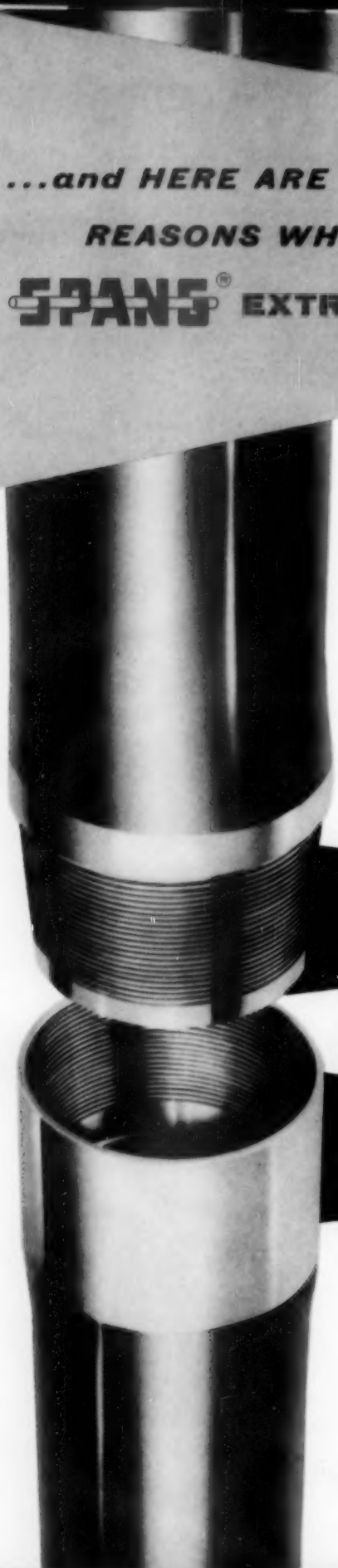
THE
NATIONAL SUPPLY
COMPANY

SPANG-CHALFANT DIVISION
MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.
DIVISION TUBULAR OFFICES: Denver, Colorado; Houston, Texas; Fort Worth, Texas; Los Angeles, California; Toledo, Ohio; Tulsa, Oklahoma; Calgary, Alberta, Canada

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE • SUPERIOR AND ATLAS ENGINES

See the next page for information on another important SPANG tubular product...

...and HERE ARE 10 GOOD REASONS WHY IT PAYS TO USE SPANG® EXTREME LINE® CASING



1. Precision-made
2. Thoroughly field-tested
3. Streamlined for maximum running efficiency
4. Easy to handle
5. Can be re-run repeatedly
6. Has a minimum number of threaded connections
7. Has high joint strength
8. 100% leak-resistant
9. Joint highly resistant to damage
10. Available in three grades for varying well conditions

Your National Supply Representative will be glad to give you more information about Spang Tubular Products. See him soon.

GRADE **J·55** — 55,000 PSI MINIMUM YIELD STRENGTH

GRADE **N·80** — 80,000 PSI MINIMUM YIELD STRENGTH

GRADE **P·110** — 110,000 PSI MINIMUM YIELD STRENGTH

THE NATIONAL SUPPLY COMPANY

SPANG-CHALFANT DIVISION

MAIN OFFICE: Two Gateway Center, Pittsburgh 22, Penna.

DIVISION TUBULAR OFFICES: Denver, Colorado; Houston, Texas; Fort Worth, Texas; Los Angeles, California; Toledo, Ohio; Tulsa, Oklahoma; Calgary, Alberta, Canada

NATIONAL BLUE OIL FIELD MACHINERY AND EQUIPMENT
SPANG STEEL PIPE • SUPERIOR AND ATLAS ENGINES

stainless steels are thoroughbred, too

The experienced exhibitor rents extra stalls... leaves them empty... to prevent contamination of his thoroughbred pets by canine neighbors.

To develop their best qualities demands *exclusive* care. That is why Sun Ship's new Alloy Products Shop has been planned for the *exclusive* fabrication of stainless and alloy steel products. When you have selected from the many available Alloys a stainless steel best suited for your service condition, you have done only half the job. You must also provide for the best possible fabrication if you are to have full protection—"A Thoroughbred Job."

Why entrust stainless steel to be fabricated in the same shop where carbon steel products are fabricated, and subject this precious metal to contamination with iron fragments, dust, or other harmful elements? A segregated shop is your answer.

Sun Ship now operates an all-alloy shop, one especially built and equipped for fabricating stainless and alloy products as they should be—segregated from carbon steel fabrication.

We emphasize the fabrication of medium and heavy stainless, alloy and aluminum products for industry.

Try Sun Ship for stainless fabrication as it should be done.

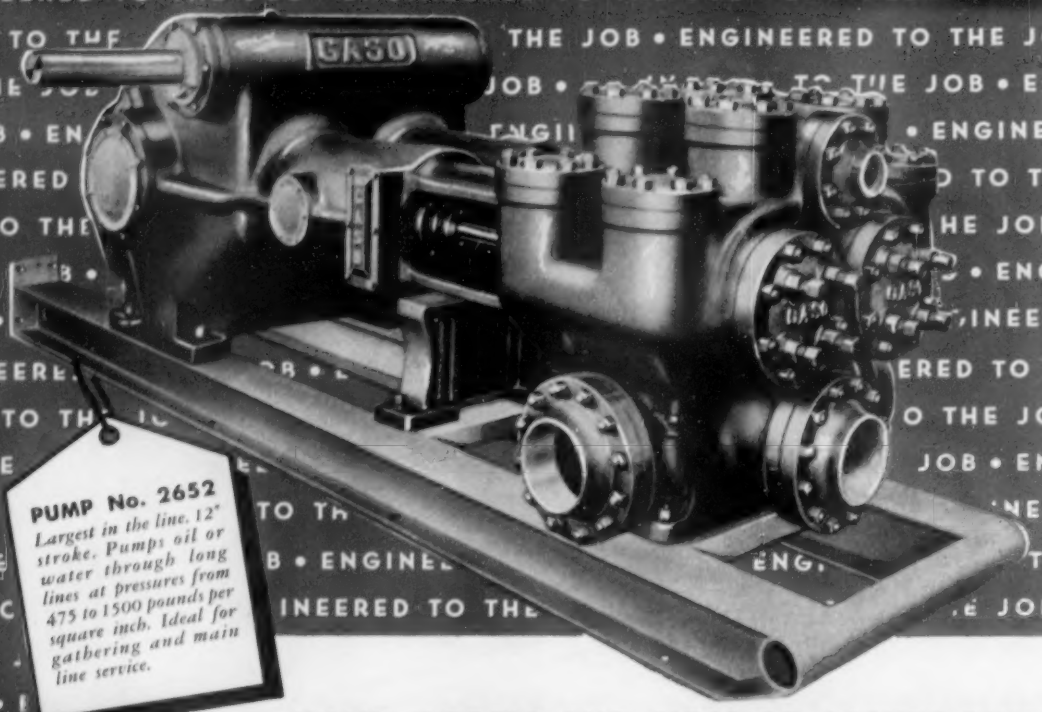
Our Sales Engineering Department will be pleased to assist you with any of your fabrication problems.

Sun Ship also makes all types of carbon steel pressure vessels.

ALLOY PRODUCTS SHOP

OF Sun SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE • **CHESTER, PA.** • 25 BROADWAY, NEW YORK CITY



PUMP No. 2652
Largest in the line. 12" stroke. Pumps oil or water through long lines at pressures from 475 to 1500 pounds per square inch. Ideal for gathering and main line service.

MANY MODELS AND SIZES TO ASSURE PUMPS

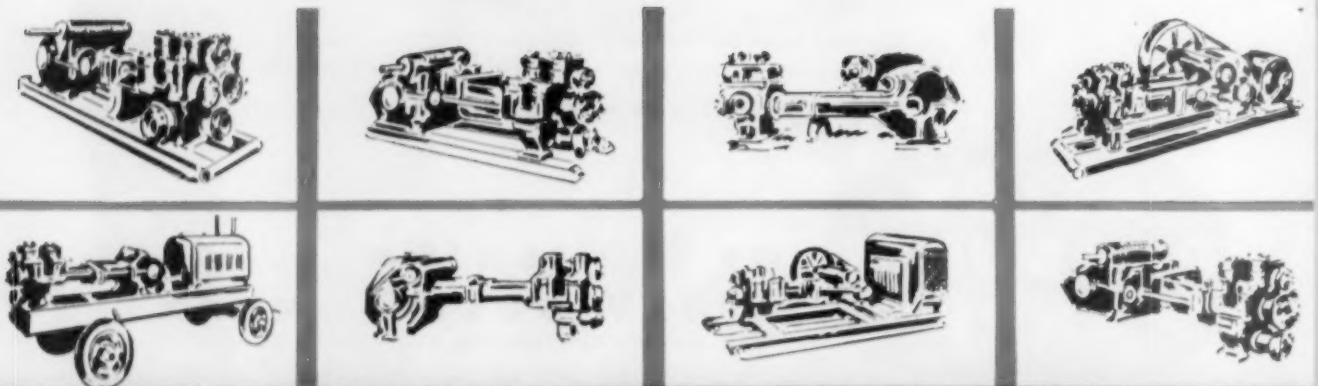
ENGINEERED TO THE JOB

It's a fact worth repeating: *Gaso offers the oil industry's most COMPLETE line of portable pumps,* developed through more than a third of a century to meet every need. Whatever your requirements, you will find in the Gaso line a size and model engineered to the job . . . with inbuilt capacity to deliver maximum performance with minimum maintenance for unbelievably long periods of time. Write for latest catalog.

GASO PUMP & BURNER MFG. CO. TULSA, OKLAHOMA
EXPORT OFFICE - 149 Broadway, New York

LUFKIN MACHINE CO. Ltd., Edmonton, Alberta
W. L. SOMNER COMPANY, Shreveport, Louisiana
Tinsley, Mississippi • Brookhaven, Mississippi • Odessa, Texas
POWER PUMPS, INC., Long Beach, Calif.
PEDDLERS, INC., Houston, Texas
NORTEX ENGINE & EQUIPMENT CO., Wichita Falls, Texas
LUFKIN FOUNDRY & MACHINE CO., Casper, Wyoming

GASO PUMPS
for every oil industry need



GASO - THE COMPLETE LINE OF PORTABLE PUMPING UNITS

DAVISON M-S® Catalyst

The Petroleum Industry's MOST WIDELY USED CATALYST!

- Narrow range of particle size distribution
- Low impurities
- Outstanding physical and catalytic characteristics
- Excellent attrition resistance

These are some of the reasons why Davison's Catalysts are the most widely used synthetic cracking catalysts in the petroleum industry. Throughout the world, Davison's catalysts crack more gas oil than any other catalyst.

Write today for a folder giving all the facts on Davison's M-S Catalysts . . . particle size distribution, chemical, physical and catalytic properties, etc.

Progress Through Chemistry

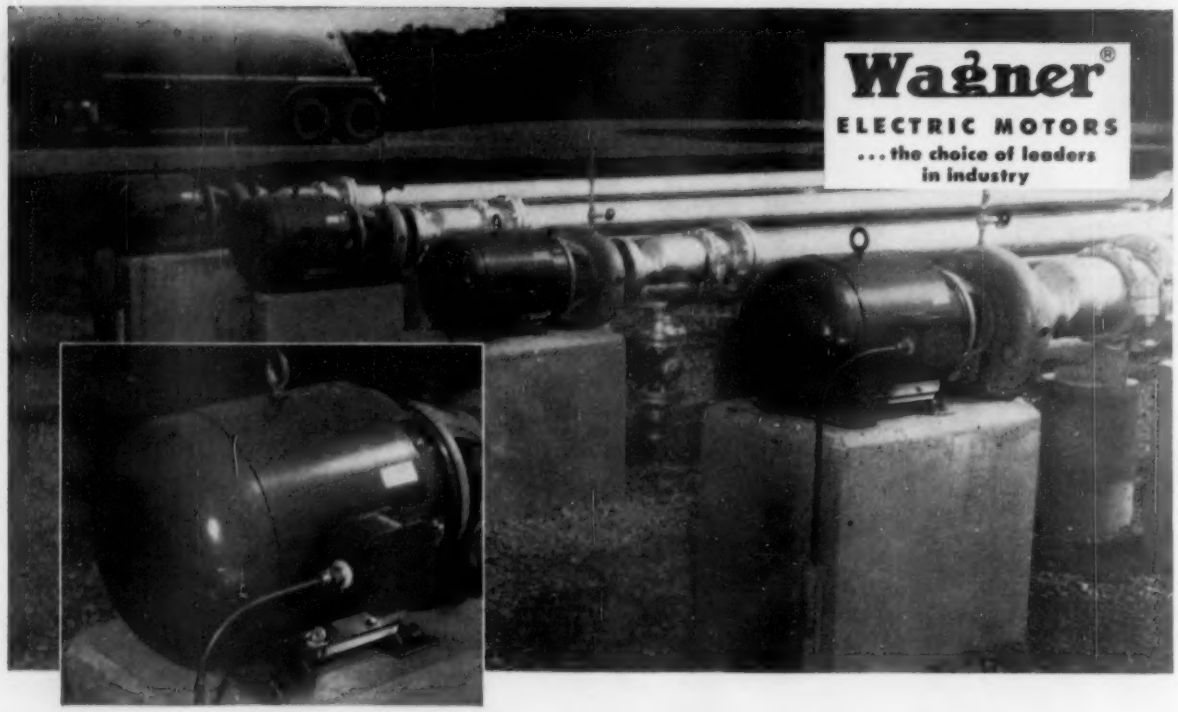
DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

Sales Offices: New York, N. Y.; Chicago, Ill.; Houston, Texas

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizers.



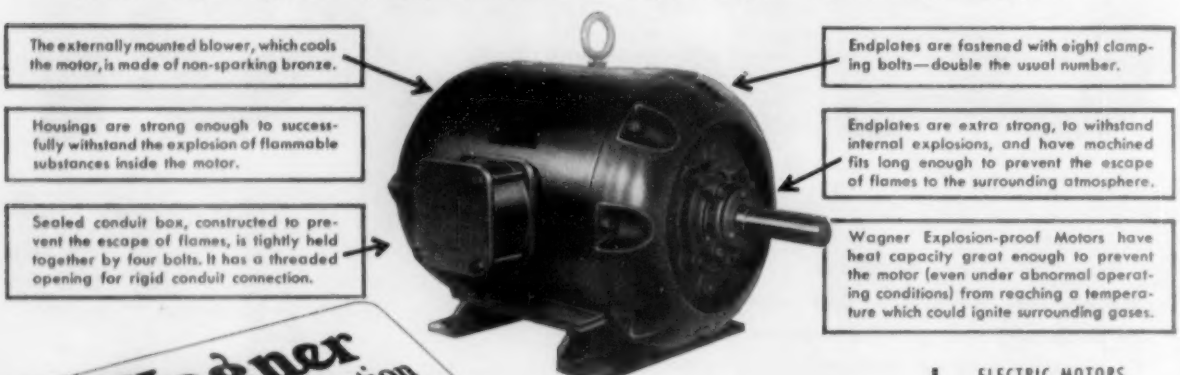
use Wagner Explosion-Proof Motors for *EXTRA PROTECTION* in explosive atmospheres

A single spark in a hazardous atmosphere can cause tremendous explosion and fire damage in less time that it takes to tell.

Motors that operate in explosive atmospheres must be absolutely non-hazardous as far as spark or flame are concerned. Wagner Explosion-Proof Motors qualify perfectly for such applications. That's why these Wagner Motors are the time-tested favorites of the petroleum industry—in the field and in the refinery. They are approved by Underwriters Laboratories for Class 1 Group D hazardous locations.

Wagner also manufactures a line of drip-proof 40° motors, polyphase or single-phase, especially designed for the continuous outdoor service demanded by oil well pumping applications.

Write for Bulletin MU-137 on Oil Well Pumping Motors and for Bulletin MU-185 on the complete Wagner Motor line. Thirty-two branch offices are ready to assist you in any motor application problem.


The externally mounted blower, which cools the motor, is made of non-sparking bronze.
Housings are strong enough to successfully withstand the explosion of flammable substances inside the motor.
Sealed conduit box, constructed to prevent the escape of flames, is tightly held together by four bolts. It has a threaded opening for rigid conduit connection.
Endplates are fastened with eight clamping bolts—double the usual number.
Endplates are extra strong, to withstand internal explosions, and have machined fits long enough to prevent the escape of flames to the surrounding atmosphere.
Wagner Explosion-proof Motors have heat capacity great enough to prevent the motor (even under abnormal operating conditions) from reaching a temperature which could ignite surrounding gases.

Wagner Electric Corporation
EST. 1891

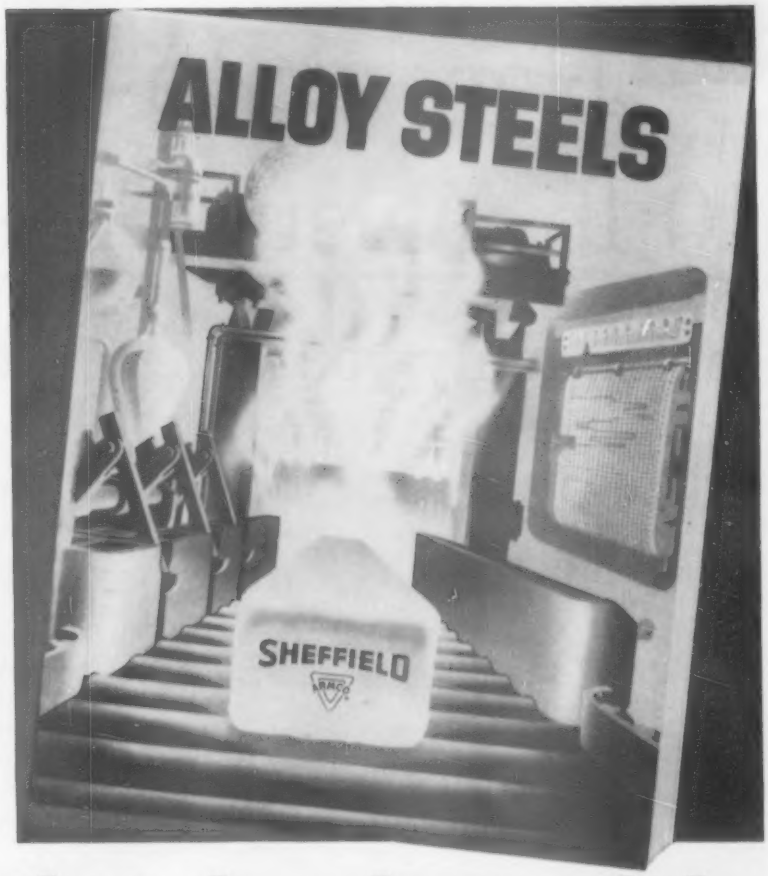
WAGNER ELECTRIC CORPORATION
6389 PLYMOUTH AVE., ST. LOUIS 14, MO., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS
TRANSFORMERS
INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

M55-9

This new book helps manufacturers give users better values in . . .



products that do a better job

Whether it's a valve spring or a home refrigerator, an airplane or a piece of oil field equipment . . . wherever greater strength per unit of weight and higher resistance to corrosion are important, products are made better and more economically with Sheffield alloy steels.

This book, "Alloy Steels," tells how Sheffield combines elements in steelmaking to produce metals with just about any combination of properties you want—hardness, ductility, high strength-to-weight ratio, forgeability, machinability and so on. In "tailoring" steel to specific product demands, Sheffield assures precise adherence to specifications by applying the most advanced chemical, electronic and mechanical tests at every steelmaking step.

If you're a manufacturer or otherwise engaged in the metal-working industries, write for your copy of "Alloy Steels." This new book covers the subject completely and concisely: applications, specifications and full technical data. Learn how you can have the sales-increasing advantages of these premium metals, often at savings in delivered costs.

SHEFFIELD
ARMCO
High Strength
Low Alloy
•
Shef-Ten
•
Forging
and Aircraft Quality
ALLOY STEELS

SHEFFIELD STEEL
DIVISION
ARMCO STEEL CORPORATION
SHEFFIELD PLANTS HOUSTON KANSAS CITY TULSA

New multi-purpose 10 lb. Ansul Extinguisher

can simplify your fire protection problem

Easy-to-operate Ansul 10-pounder gives fast, effective results. Light weight makes it easy for women to use.

The 10-pounder stands up under rugged road use. Built to give dependable service after extreme exposure. Listed by Underwriters' Laboratories.

New rugged unit gives you high fire killing rating, light weight, modern design

The new Ansul 10-pounder is *designed* and *constructed* for all-around plant use—wherever dry chemical protection of this capacity is called for. It is ideally suited for truck protection, other outdoor hazards and indoor use. This multi-purpose advantage means that you have fewer models of extinguishers to service and a less complicated training program to maintain.

The high fire killing rating (B1, C1) of this unit gives you *effective* protection the *instant* it's needed. Another advantage of the Ansul 10-pounder is its light weight. This feature is important where women are called upon to lift and operate the unit. This extinguisher is also modern in appearance. It was styled by Raymond Loewy to be *seen* in any location—in the office, laboratory, plant, or on a truck.

Have the Ansul Man review your class B and C hazards, those involving flammable liquids, gases, and electricity. He will show you how the Ansul 10-pounder can make your fire protection program easier to administer, more economical to maintain.

Call the Ansul Man!

Get in touch with your local Ansul man through the "yellow pages" or write ANSUL CHEMICAL COMPANY, Fire Equipment Division, Dept. F-95, Marinette, Wisconsin. *Write Ansul for your copy of new Fire Equipment Catalog.*

ANSUL

Serving

THE OIL AND GAS INDUSTRIES

. . . through well-stocked stores

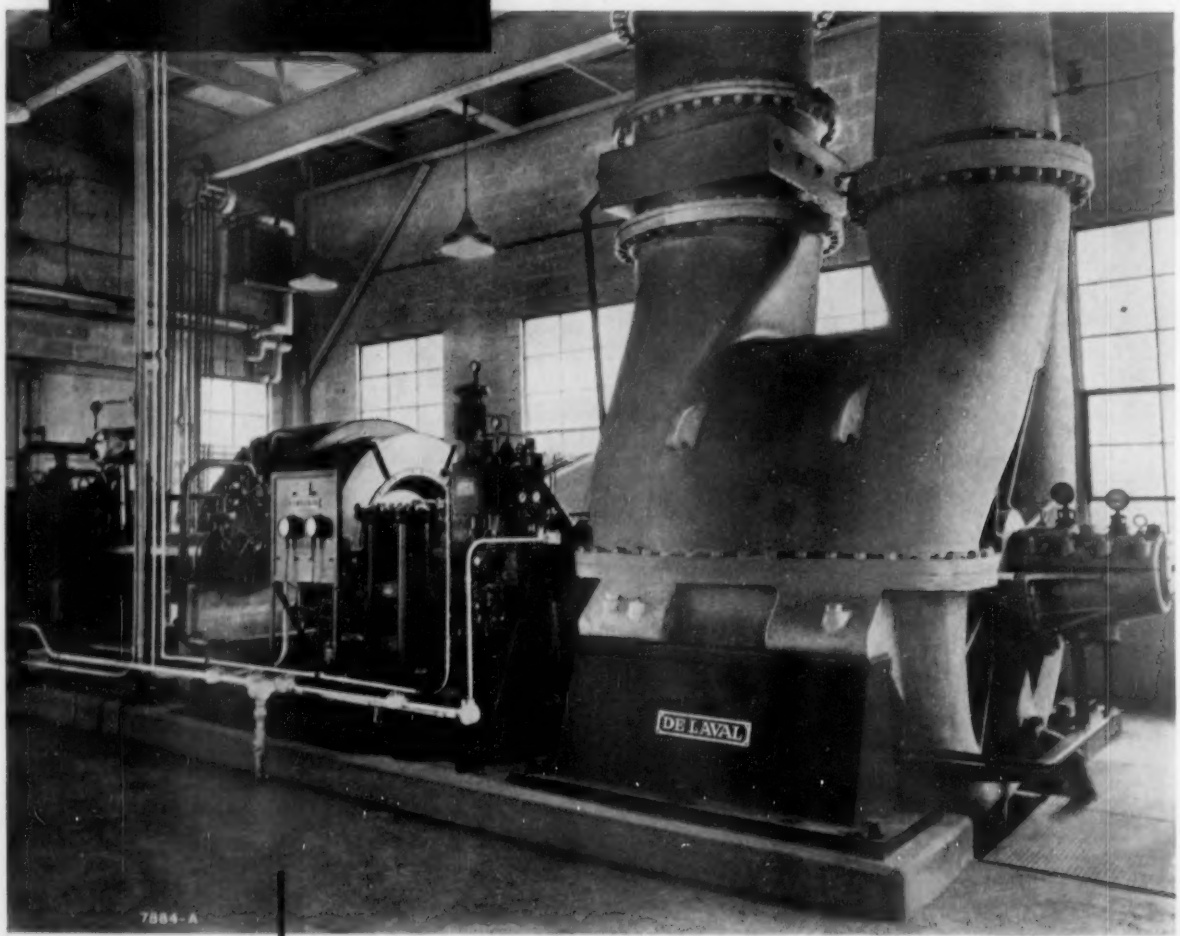
in all principal oil fields.

THE CONTINENTAL SUPPLY COMPANY

General Offices: DALLAS, TEXAS

DE LAVAL CENTRIFUGAL BLOWER

supplies 48,400 cfm for new British American cat cracker



Send for new Bulletin 0504

This De Laval centrifugal blower does a dependable job in the new Model B Orthoflow cat cracker of the British American Oil Co., Ltd. at Clarkson, Ontario.

The unit delivers 48,400 cubic feet of air per minute for the regeneration of spent catalyst. Inlet pressure is 14.2 psia, and discharge pressure 35.4 psia. The De Laval blower operating at 3,700 rpm is driven through a speed increasing gear by a 4,500 hp electric motor.

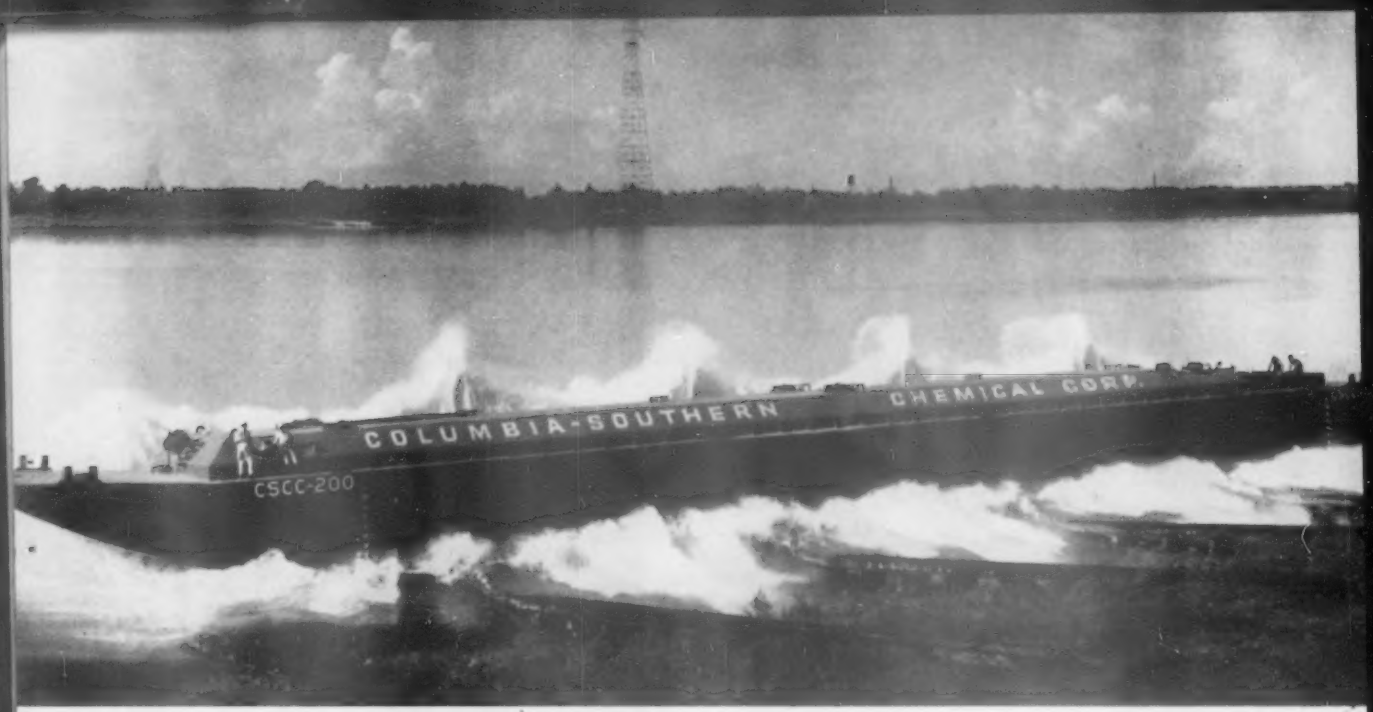
De Laval blowers are designed and built for heavy duty continuous operation. Rugged, horizontally split casings, individually designed impellers, perfectly balanced rotors and externally mounted, cylindrically seated bearings are design features that assure optimum performance and long service.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

810 Nottingham Way, Trenton 2, New Jersey

DL307



THIS BIG SPLASH IS MAKING CHEMICAL HISTORY

Here's the newest of a long list of Columbia-Southern achievements in the transportation and handling of industrial chemicals. The launching, pictured at New Orleans, is of one of Columbia-Southern's new fleet of advanced-design caustic soda barges.

The development of the industry's most advanced barge fleet is a natural outgrowth of Columbia-Southern's pioneering research and development in transporting liquid caustic soda by both rail and water. Distinctive features of this new fleet include newly designed electric pumps that speed and simplify unloading; Pittsburgh Fiber Glass insulation and the most modern steaming facilities; Columbia special tank lining and nickel pump fittings to prevent metallic contamination of the caustic; complete safety construction and equipment.

Setting the pace in chemical transportation is one of many contributions to the chemical industry by Columbia-Southern, a leading producer of chlorine, alkalies and related chemicals.

On Columbia-Southern's new barges, one end is sharply raked, while the other is flat. This permits far greater maneuverability. Also, more barges can be moved faster with the same towboat power. These barges are equipped with two caustic soda cargo tanks, each of 600 ton capacity, especially mounted and insulated to facilitate unloading.

COLUMBIA-SOUTHERN CHEMICAL CORPORATION

SUBSIDIARY OF PITTSBURGH PLATE GLASS COMPANY

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CHLORINE, ALKALIES AND RELATED CHEMICALS • OFFICES IN PRINCIPAL CITIES

At last!

A TRUE VINYL MASTIC!

Complete protection in a single coat—10 mils thick.

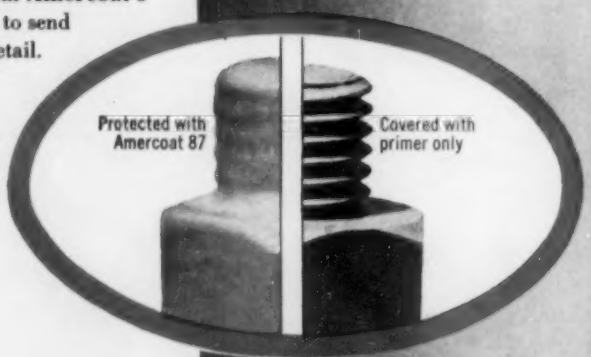
Amercoat No. 87 will cut your maintenance costs because one coat gives you the thickness and protection previously available only through the application of multiple coats.

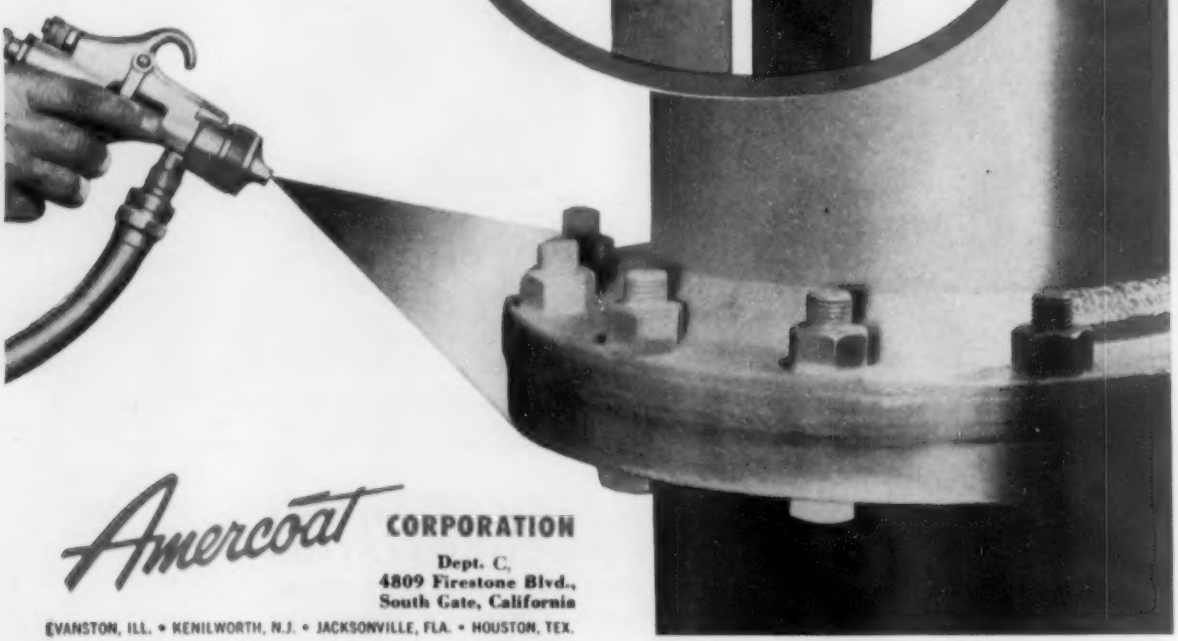
Amercoat No. 87 is the brand new solution to an old problem, for it combines the time-tested chemical and weather resistance of a vinyl with the extra thickness that was heretofore available only in conventional mastics.

Amercoat No. 87 is easily applied with standard industrial spray equipment. Only one cross-spray coat, over a primed surface, is required for complete protection. Because **Amercoat No. 87** is a true vinyl, it is not limited to black, but is available in a variety of colors.

You can save up to 50% of your labor costs with **Amercoat's new vinyl mastic No. 87.** We will be pleased to send you a bulletin describing this new coating in detail.

Notice that the sharp bolt threads, welds and sharp corners are completely protected with one coat of Amercoat No. 87—10 mils thick!





Amercoat CORPORATION

Dept. C,
4809 Firestone Blvd.,
South Gate, California

EVANSTON, ILL. • KENILWORTH, N.J. • JACKSONVILLE, FLA. • HOUSTON, TEX.

DIGGING PROBLEMS

are not the only problems!

Northwest Crawlers get you there and back!

Perhaps on no other kind of job is a Pullshovel, Dragline, Shovel or Crane called on to travel so much as on a pipeline. Not only does it generally call for miles of travel but water crossings and the rugged nature of back country away from roads, taxes a crawler to the limit.

The picture, above, shows one of Ray L. Smith Construction Company's Northwests on a water crossing. This well-known pipeline company is now using its 9th Northwest. The Ray L. Smith people know what real Northwest mobility means.

Northwests meet the daily, unexpected problems that every job presents. Northwest Crawlers, with their self-cleaning action have proved themselves in miles of travel. Where there are grades to climb, streams to ford or rough going to negotiate, your Northwest gets you there and back. Your Northwest is a combination of advantages that mean money. Properly engineered power plants, the "Feather-Touch" Clutch Control, Uniform Pressure Swing Clutches, the Cushion Clutch, Boom Hoists to meet every condition, easy convertibility — mean faster output and smoother operation on the pipeline. Why not find out about Northwest for your next job? Ask for details.

NORTHWEST ENGINEERING COMPANY
1517 Field Building, 135 South LaSalle Street
Chicago 3, Illinois

NORTHWEST

CRAWLER and TRUCK MOUNTED SHOVELS • CRANES • DRAGLINES • PULLSHOVELS

NORTHWEST ENGINEERING COMPANY
135 South La Salle Street, Chicago 3, Illinois

Please send me complete information and catalogs on equipment as checked:

☐ Shovel ☐ Crane ☐ Dragline ☐ Pullshovel

☐ Truck Crane Capacity _____

Name _____

Address _____

Town _____ Zone ____ State _____

Signed _____

new Limitorque® economy...

greater valve stem capacity

gives more torque

withstands greater thrust

compact and simple

features

Two piece stem nut design permits changing unit from one valve to another. Torque control for both directions of stem travel or single direction as required. Easier handwheel operation. Improved switch design and electrical arrangement. Either torque or geared limit control operation. Easier declutching.

no complicated gear drives

minimum friction losses

most economical and dependable operator for all small valves.

Do you have need for a small, low cost automatic valve operator that will give you rapid operation control of your valves? If so, the SMA-00 and SMA-000 is the answer. They are readily adaptable to all types of valves, including gate, plug, globe and butterfly.

Size for size these units are designed for greater valve stem capacity, will produce more stem torque, and will withstand greater thrust than any other valve operator on the market. Also, should a power failure occur, LimiTorque can be operated by the hand wheel.

It will pay you to secure full details regarding this exclusive, accurate and powerful small valve operator. We suggest that you send for new LimiTorque Bulletin 1A-54 which illustrates and describes the construction and operation of these little giants.

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G ST., PHILADELPHIA 34, PA.
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LimiTorque Corporation Philadelphia

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

HOW TO EARN AN ENCORE IN THE PETROLEUM INDUSTRY

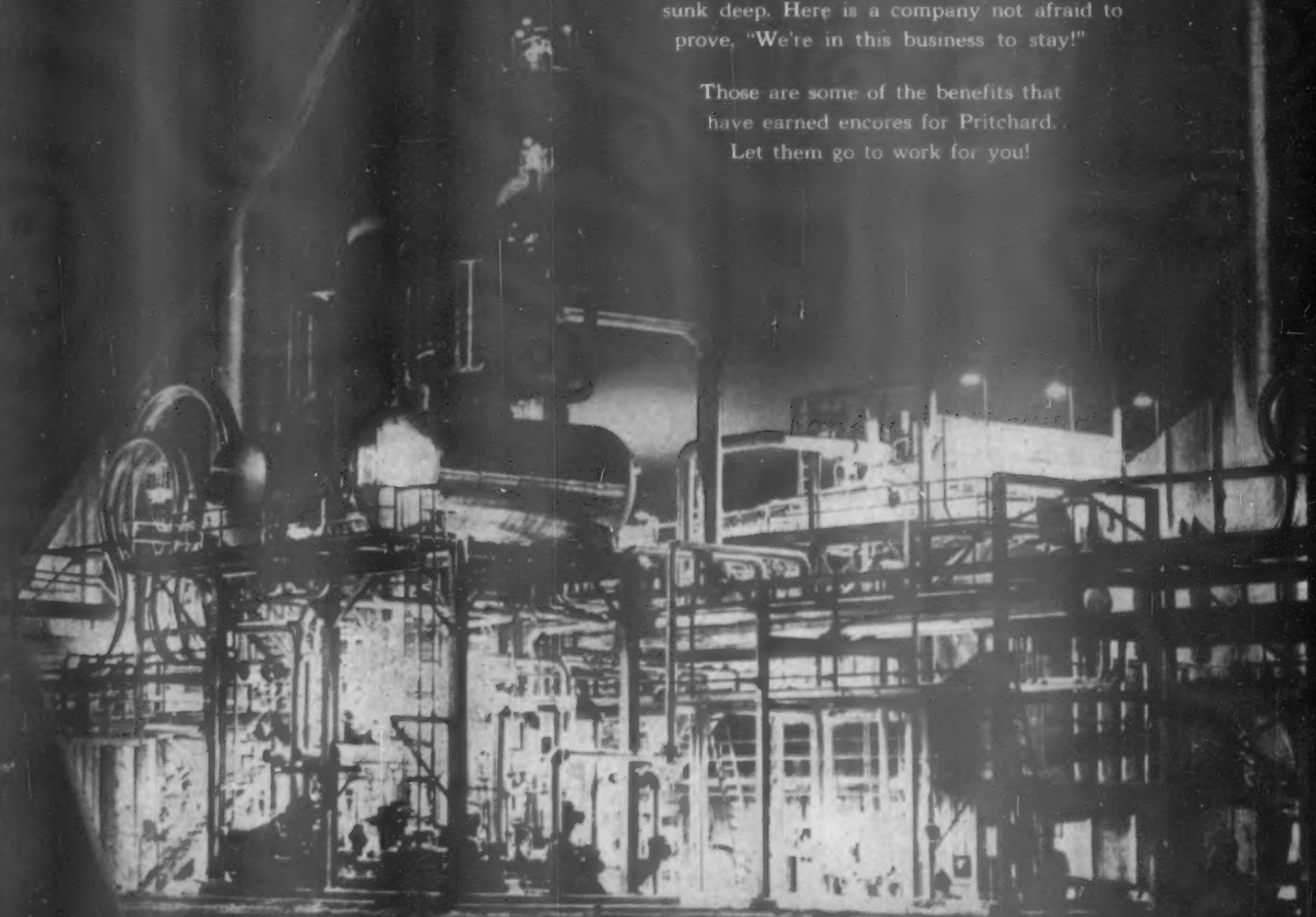
Get the job done right!

That's why Pritchard is proud of its many encores in the design, engineering and construction of refineries and off-site facilities. The many companies who chose Pritchard again after a successful initial experience are evidence of Pritchard's ability *to get the job done right* . . . and right on time.

These companies also appreciate Pritchard's single responsibility contract. They enjoy the extra cooperation Pritchard personnel offer their staffs, all the way down the line.

They value Pritchard's permanency. They know that here is a company whose roots are sunk deep. Here is a company not afraid to prove, "We're in this business to stay!"

Those are some of the benefits that have earned encores for Pritchard. Let them go to work for you!



Refinery off-site facilities designed, engineered and constructed by J. F. Pritchard & Co.

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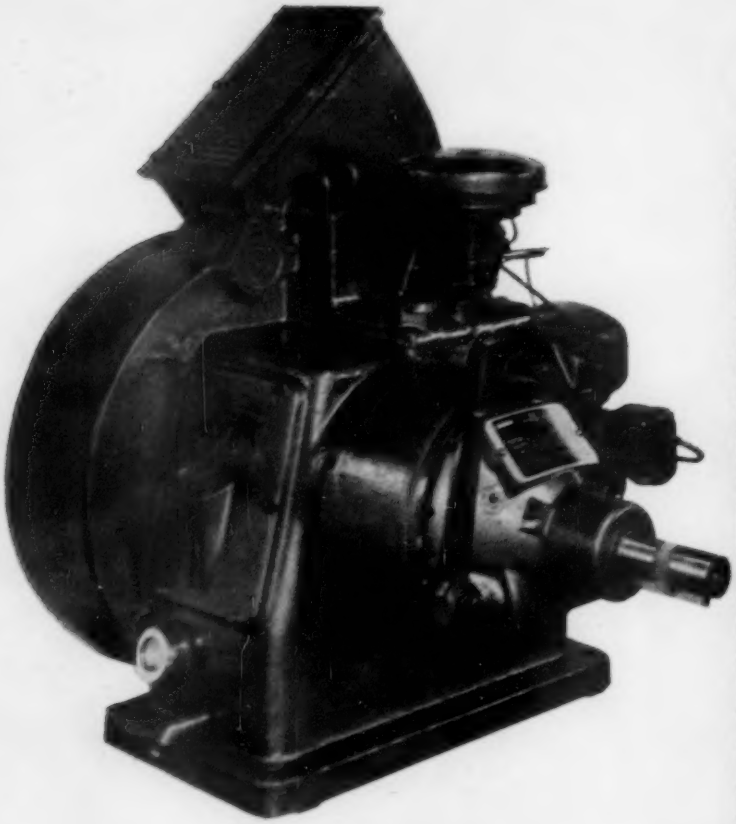
ENGINEERS • CONSTRUCTORS

Dept. 430, 4675 Roanoke Parkway, Kansas City 12, Mo.



New LeRoi A114 Pumping Engine

A single-cylinder, valve-in-head engine with 114 cu. in. displacement, built specifically to give you economical operation with little attention.

Here it is — an engine that can pump more oil than any other engine of equal displacement. You can run it two weeks at a time without inspection, because the patented "vaporizing condensing" cooling system seldom needs make-up water. Moreover, a generous crankcase permits long intervals between oil changes, and there are no grease fittings, belts, or other accessories to need attention.

Performance is only half of the A114 story— the other half is dependability. Here are a few of the features that give the A114 its stamina:

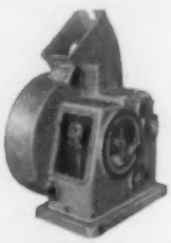
The A114 operates on natural gas or LPG.

Get all the facts about this new 14.5 hp pumping engine from your supply house or your Le Roi distributor. Or, write for our latest bulletin E-8.

Two extra large flywheels provide generous WR2 values for smooth, constant-speed pumping even with unbalanced loads.

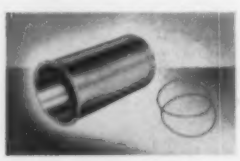
Valve-in-head design produces maximum power with minimum fuel consumption. Short stroke design reduces piston speed and lessens cylinder wear.

Short, counter-balanced crankshaft, 3" in diameter, has extreme overlap between crank pin and main bearing journals for added strength and rigidity.



Heavily constructed and internally ribbed, integral crankcase and base eliminate any possibility of distortion.

One-piece fan and flywheel is totally enclosed in a specially built air duct. No fan or belt to maintain or replace.



Removable, wet-cylinder sleeves assure easy, low-cost replacement of cylinder wearing surface.

LE ROI *Division of Westinghouse Air Brake Co.*

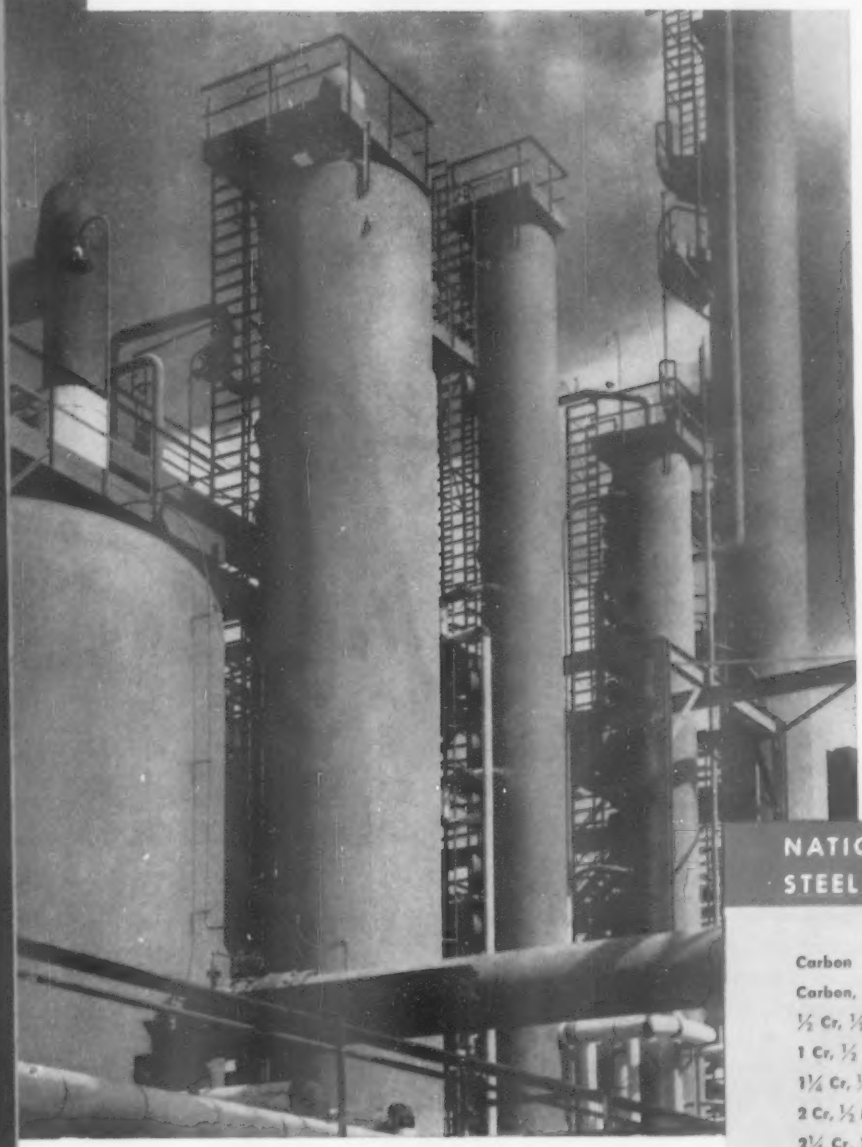
Milwaukee 14, Wisconsin

Oilfield Headquarters: Tulsa, Okla.

PORTABLE AIR COMPRESSORS • TRACTAIR • STATIONARY AIR COMPRESSORS • AIR TOOLS • ENGINES

P-128

LET US HELP YOU WITH YOUR REFINERY TUBING PROBLEMS



WHAT'S YOUR particular problem? Corrosion? Oxidation? Exposure? High or low temperatures? No matter what it is, our engineers would like a chance to help you solve it. Refinery problems are their specialty.

Certainly there are a lot of things to consider when you're selecting refinery pipe or tubing—basic differences in equipment, for instance, or variations in fabricating operations, required service pressures, presence of corrosive media, and many other factors which will determine the steel analysis you must use.

For over 60 years, National Tube has maintained a file of case histories on refinery tubing problems—and we've come up against just about all of them. Using this experience file, our engineers have developed 25 different steel tube analyses—each for combatting specific refinery conditions. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study. These analyses are at your disposal.

Look over the list shown here. Then before you choose your new pipe or tubing, consult our engineers to be certain that you get the right analysis—the one that will do the best job at the lowest cost. Write to: National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

NATIONAL TUBE'S 25 DIFFERENT STEEL TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	18-8
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8 Ti
½ Cr, ½ Mo	7 Cr, ½ Mo	18-8 Cb
1 Cr, ½ Mo	8 Cr, ½ Mo	18-8 Mo
1¼ Cr, ½ Mo	8 Cr, 1 Mo	25-20
2 Cr, ½ Mo	9 Cr, 1 Mo	3½ Ni
2¼ Cr, 1 Mo	12 Cr	5 Ni
2½ Cr, ½ Mo, ¾ Si	12 Cr, Al	
3 Cr, 1 Mo	17 Cr	

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

WALLS WITHOUT WELDS

NATIONAL SEAMLESS PIPE AND TUBES

USS

UNITED STATES STEEL

DESIGN
ENGINEERING
PROCUREMENT
CONSTRUCTION

It's a complex skill, this business of seeing in a blue print the finished project . . . of visualizing the operation of a processing plant from a maze of lines and symbols on a sheet of paper . . . or translating an algebraic equation into the production capacity of a chemical plant.

Yet here at Procon it's all in a day's work. It has to be, for Procon engineers are entrusted with the creating and building of many different types of processing plants. You'll find these men at home in every phase of process construction . . . at the drawing board . . . around the conference table or on the job site. They are typical of the men who are Procon . . . who have been responsible for the recognition which this organization has achieved among leaders of industry.

PROCON *Incorporated*

PROCESS CONSTRUCTION

1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

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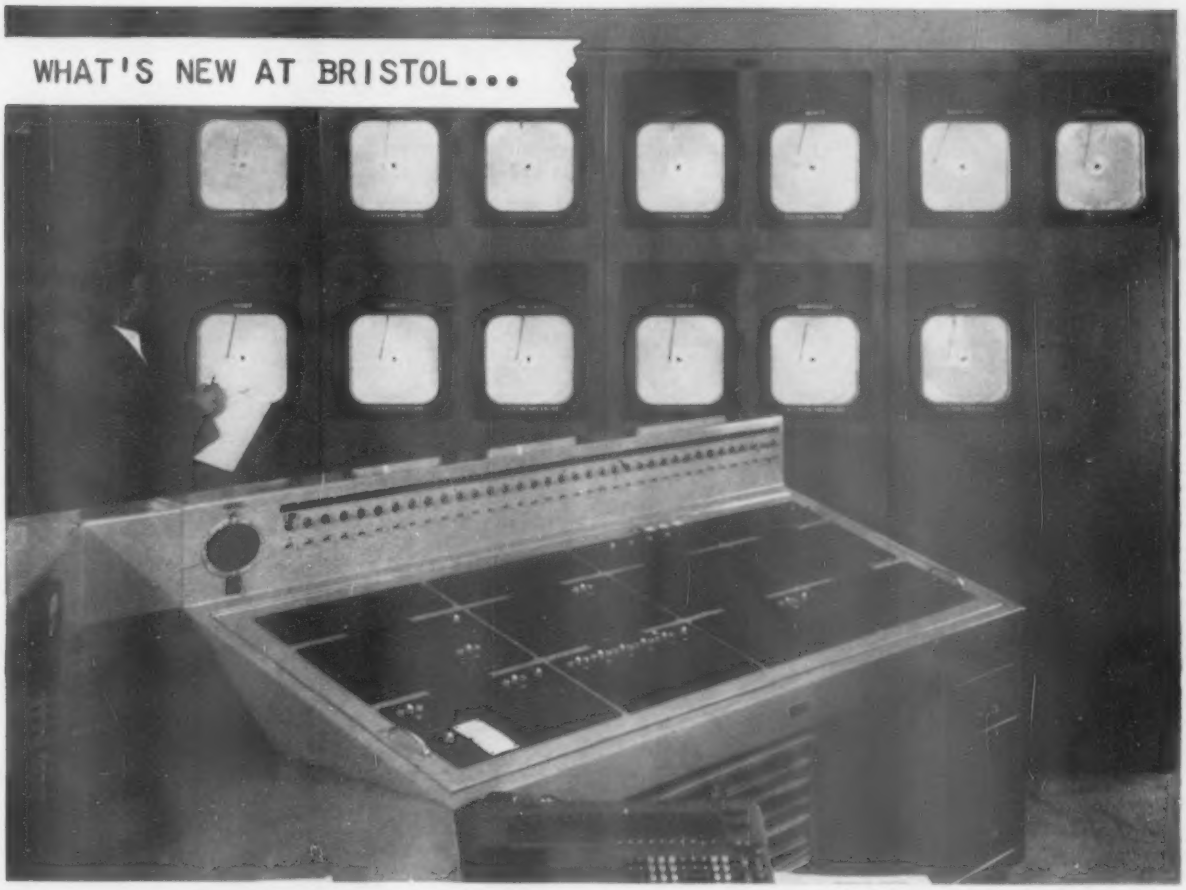

BRISTOL METAMETER* TELEMETERS in the Kansas City office of the Platte Pipe Line Company continuously record suction and discharge pressure, flow, and static pressure all along Platte's 192,500 b/d crude oil pipeline. Operations in the 1000-mile network of pipe are controlled from this central dispatching office – a situation made possible by continuous measurement at critical points.

*Reg. U.S. Pat. Off.

Taking the pulse of a 1000-mile pipeline

FROM THE ROCKIES to St. Louis, crude oil is monitored every foot of the way by Bristol instruments.

Why did Platte select Bristol Metameter Telemeters for their 1000-mile pipeline? Simply because it's good business to do business with Bristol—acknowledged leader in telemetering for over 43 years. Drop us a line today for the whole Bristol story.

Write the Bristol Company, 120 Bristol Road, Waterbury, Conn.

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BRISTOL

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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

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for Stainless Steel flanged and dished heads

That's the thing to do if your requirements call for flanged or dished heads made from stainless steel.

Our extensive and specialized equipment for head-forming enables us to supply you with stainless-steel heads in all practical diameters; in light and heavy thicknesses.

To order, contact our nearest sales office or write direct to Claymont Steel Products, Wickwire Spencer Steel Division of CF&I, 813 West Street, Wilmington 99, Delaware.

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2766

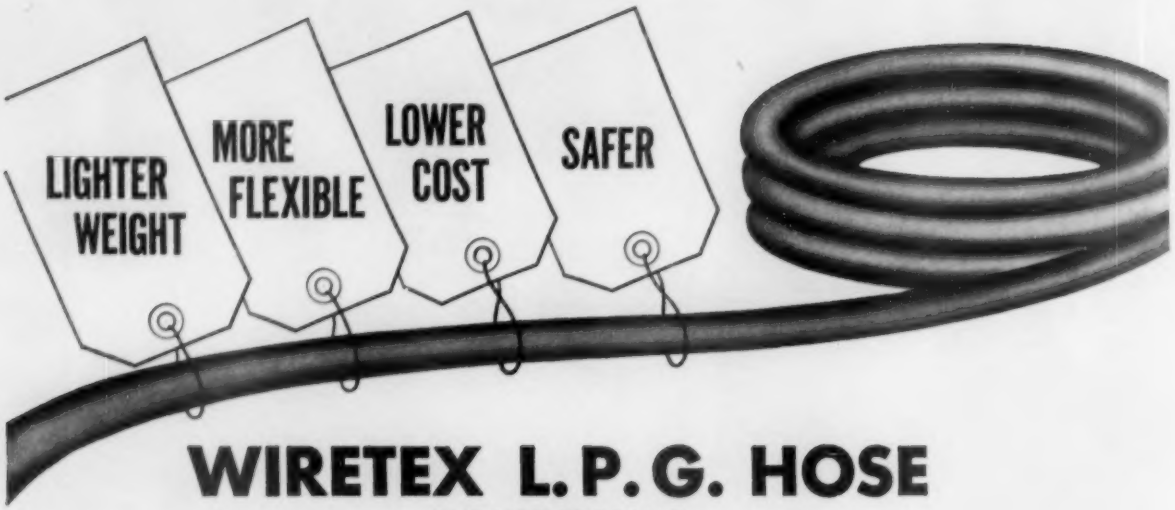
Additional profits for operators everywhere are realized by recovering good, useable oil from basic sediment and water. Pumping from storage tank bottoms to heater treaters to save the oil normally burned each year in slush pits, is one of many jobs Marlow Self-Priming Centrifugal Pumps do quickly and efficiently throughout the oil country.

marlows are durable!

Marlow Self-Priming Pumps and Marlow "Mud Hog" Diaphragm Pumps make a team that can't be beat for tough oil-country pumping jobs. Marlows have proved their durability for majors and independents alike on rugged trouble-free service. Veteran oil men are making Marlow their first choice for long, dependable service. Make sure with Marlow . . . get the facts from your Marlow dealer or write for Bulletin O-53.

MARLOW PUMPS • RIDGEWOOD, NEW JERSEY

Division of BELL & GOSSETT COMPANY



WIRETEX L.P.G. HOSE

BUTANE-PROPANE

LIGHTER WEIGHT— lighter by 28% than fabric reinforced hose in the popular ¾" size.

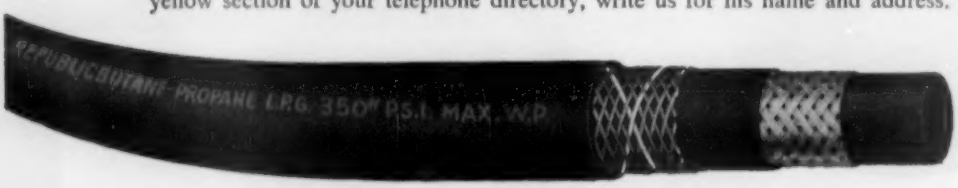
MORE FLEXIBLE— because of its wire-braid construction; easier to handle, too—in all sizes!

LOWER COST— than fabric reinforced hose.

WIRETEX L.P.G. Hose has built-in safety factor in the strength of the steel wire-braid reinforcement. For further safety, there are two static-dissipating wires spiralled into the textile braid, which forms a bond between the reinforcement and the cover.

The Reprene tube is especially compounded to handle liquid butane and propane which would be destructive to ordinary rubber. The abrasion-resisting rubber cover is colored RED for easy identification. WIRETEX L.P.G. Hose is your most economical conductor of liquid petroleum gas.

Your local Republic Distributor can help you plan, select, apply and maintain any product of Industrial Rubber. If his name is not listed in the yellow section of your telephone directory, write us for his name and address.



WIRETEX L. P. G. HOSE is available in lengths up to 60' in a full range of sizes from ½" to 2" inclusive.

SPECIFICATIONS

Spec. Number	Size I.D.	Wire Braid	Approx. O.D.	Approx. Wt. Lbs. Per 100'	Max. Wkg. Pressure Pounds	Std. Pkg. Qt.
W-63-50	½"	1	11/16"	37#	350#	240'
W-63-75	¾"	1	1 5/32"	53#	350#	240'
W-63-100	1 "	1	1½"	72#	350#	240'
W-63-125	1¼"	1	1 11/16"	105#	350#	120'
W-63-150	1½"	1	2 1/16"	135#	350#	120'
W-63-200	2 "	1	2⅓"	170#	350#	60'

"Quality Hose Builders for Over 50 Years"

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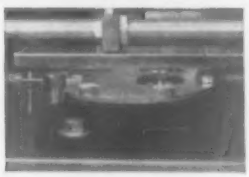
LEE RUBBER & TIRE CORPORATION, YOUNGSTOWN 1, OHIO

INDUSTRIAL RUBBER PRODUCTS

PROCESS CHANGES CAN'T OBSOLETE THIS TRANSMITTER . . .

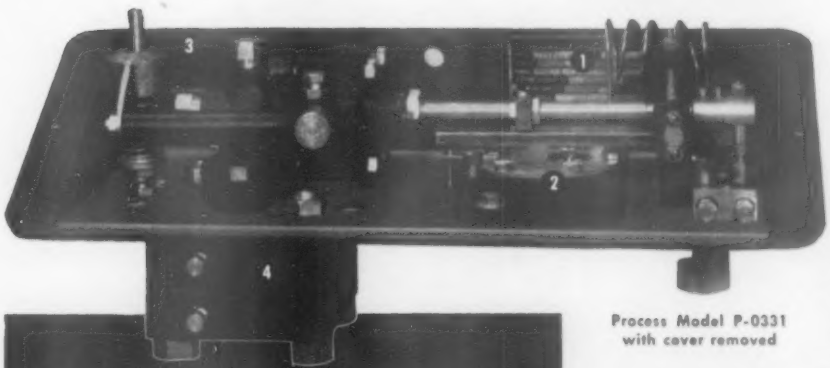
❶ 10-1 RANGE CHANGE —NO CHANGE OF PARTS

Double weighbeam construction on many models permits range changes as much as 10-1, just by turning a set of locking nuts to change a fulcrum point.

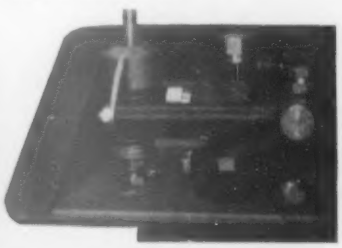


❷ ADDITIONAL 16-1 RANGE CHANGE—STILL NO PARTS CHANGE

Range may be changed on all models by loosening retaining bolts and sliding the reaction chamber to a new leverage position. Reaction area may be changed for further range change.



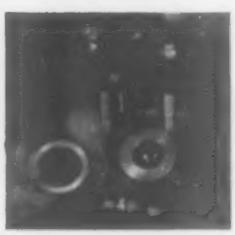
Process Model P-0331 with cover removed



❸ SUPPRESS, COMPOUND OR REVERSE RANGES

Balancing spring, installed to exert either an upward or downward force on transmitter weighbeam, quickly converts transmitter for range suppressions up to 80% of total range, for reversed ranges or for compound ranges where pressure fluctuates above and below atmospheric pressure.

REPUBLIC PNEUMATIC TRANSMITTER with EASY RANGE CHANGE



❹ MAJOR RANGE CHANGES

Range change plates may be easily inserted or removed from measuring chamber to change the effective diaphragm area for major range changes. Similar plates may be used also in the reaction chamber for further range change.

Here's the pneumatic transmitter for measuring differential, flow, pressure or level that saves you time and money when operating conditions are not definitely known or processes are likely to be changed. Extreme flexibility of design lets you adapt the same transmitter chassis for almost any range of measurements—often without any change of parts.

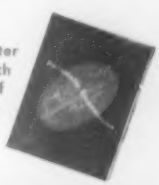
Process Model pictured above has a differential range of 0-12″ H_2O minimum and 0-880″ H_2O maximum at operating pressures to 1500 psig. Other models are available for differential ranges as low as 0-0.6 H_2O or as high as 0-750 psi.

Transmitters may be constructed of special materials to handle almost all types of corrosive fluids. Ruggedly built, they give long service out-of-doors. Accuracy is guaranteed at ½% of full range on standard models.

Republic transmitters are used in process, chemical and petroleum plants all over the country. Investigate their advantages for your plant.

FREE DATA BOOK

Get the full story about Republic transmitter flexibility. Send for free Data Book which gives all the facts about complete line of Republic transmitters, including Square Root Extracting and Pneumatic Electric models.



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PROCESS PLANTS

by

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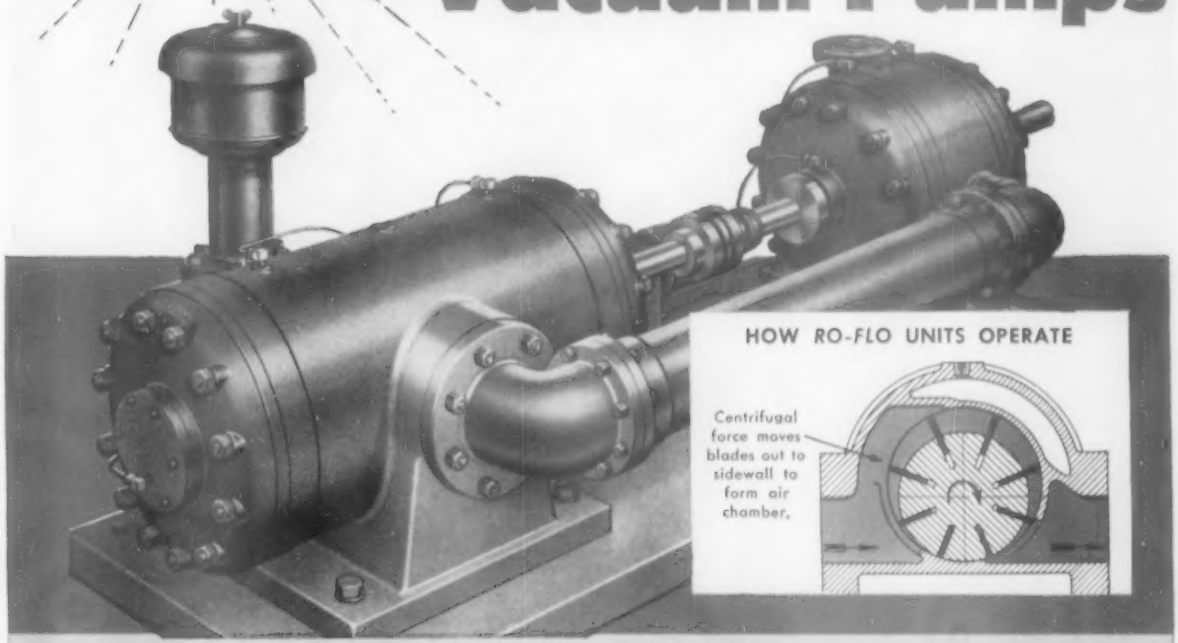
NEW

100-lb Compressors

0.3-in. Mercury Absolute Vacuum Pumps



FOR SHOP AIR • DRILLING • GAS HANDLING • VACUUM PUMPING

Now—the *Ro-Flo* line is extended to include high pressure as well as low pressure units to give you three important advantages:

Constant efficiency — Automatic compensation for wear is inherent in *Ro-Flo* design. During operation, rotor blades slide against the sidewall to form air cells. Any blade wear from this action is compensated for by the rotating force which holds blades in contact with the cylinder.

Simple foundation requirements — The smooth rotation of the *Ro-Flo* unit cuts vibration and eliminates need for heavy, expensive foundations.

Low maintenance — Shock and vibration, inherent in reciprocating machines, is eliminated. This cuts maintenance.

Two-stage *Ro-Flo* compressors can be furnished in any of 12 sizes to handle from approximately 250 to 1800 cfm at pressures from 65 to 125 pounds gauge. Vacuum pumps furnished from 200 to 5040 cfm at 29.7 inches Hg vacuum, with shut-off of 29.9 inches Hg, referred, or better. Single-stage units are built for pressures up to 50 pounds gauge, 65 pounds absolute. Single-stage pumps for vacuums up to 28 inches Hg referred.

A-4569

GET INFORMATION

Call your nearby A-C district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Ro-Flo is an Allis-Chalmers trademark.

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We thank our many friends for the opportunity they have provided us to fill their needs for

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MARSH INSTRUMENT CO. *Sales affiliate of Jas. P. Marsh Corp.*
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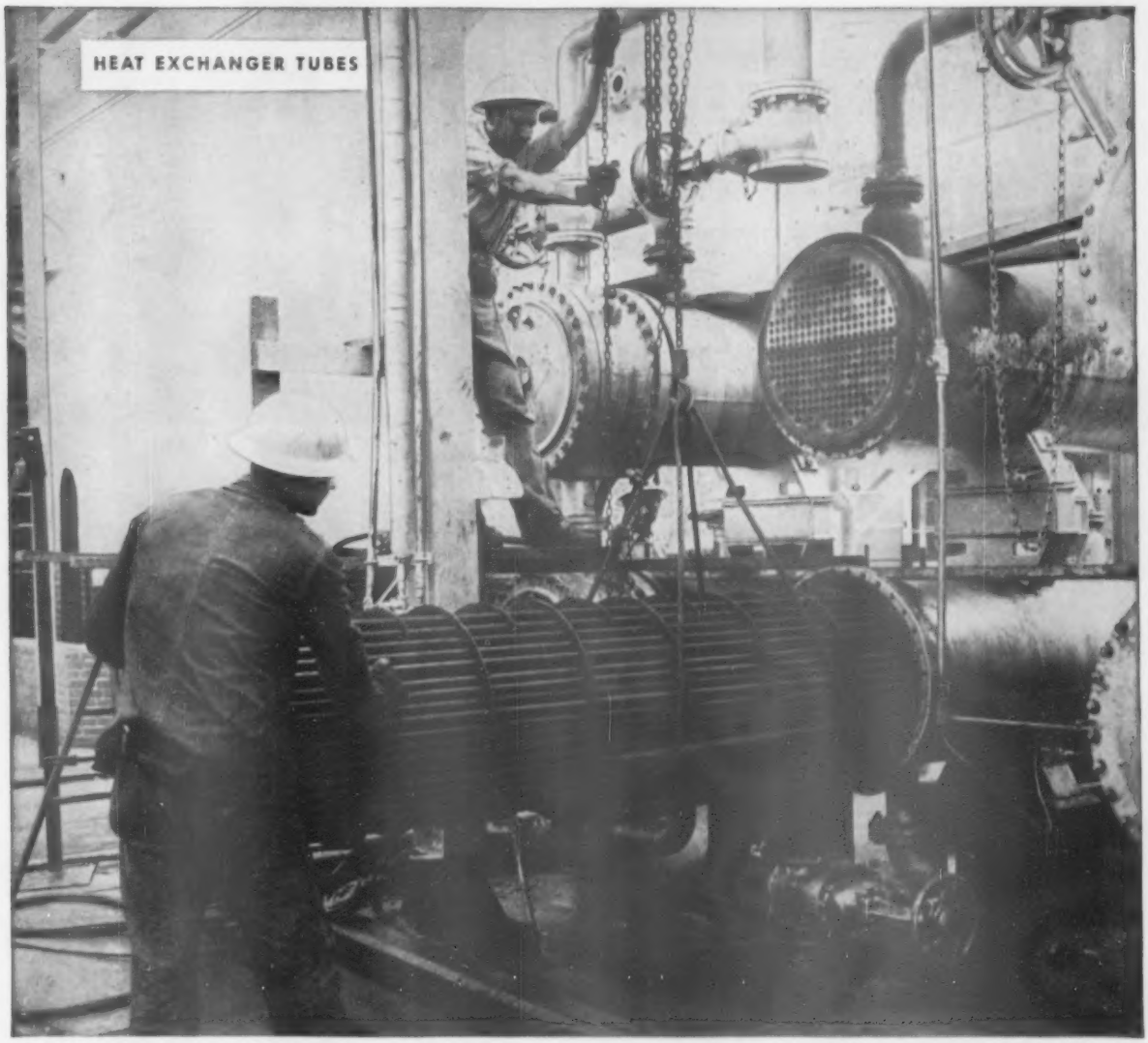

PERFORMANCE RECORD of these tubes under actual operating conditions is now a part of Anaconda's extensive collection of case histories.

Use of Anaconda Cupro Nickel, 10%-755 Tubes in Texas refinery may answer your tube problem

Imagine a collection of tube performance case histories that can answer many of the corrosion problems you face!

Our files bulge with such a collection. Here is experience accumulated over almost a century. Here are detailed records of tube performance under hundreds of actual operating conditions.

We can put the information in these files to work for you at once—to help you select the one best alloy for your job.

Here's a case history we are now adding—the use of ANACONDA Cupro Nickel, 10%-755* Tubes in the Port Neches Refinery of a major oil producer.

These tubes—in use two years—cool heavy gas oil in an Alco Exchanger on a Crude Pipe Still Unit. Gas oil at about 500°F.—mildly corrosive—comes in contact with the outside of these tubes. Brackish river water—with a high salt content—circulates through the tubes. Yet the tubes show no sign of corrosion.

CUPRO NICKEL, 10%-755 resists corrosion almost as well as Cupro Nickel, 30%-702; yet it costs much less. Polluted sea water and sea water with entrained air—even at relatively high velocity—have little effect on this alloy.

Help for your tube problem. No one tube alloy serves best under all conditions. Your problem is one of choosing the right alloy for the job. Let Anaconda's Technical Department help you. Write, outlining your operating conditions, to Dept. TD, *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*U.S. Patent No. 2,074,604 54109

ANACONDA®
Tubes and Plates
for Condensers and Heat Exchangers

What they're saying about LORAIN "E-Z" CONTROLS

"Switching between our other machine and this new 'TL' makes me really appreciate these new, easy controls."
Operator Al Hallett, Lorain County Excavating Co., Elyria, Ohio

"Hell, I wouldn't kid you . . . this 'TL' is a sweet running machine."
Operator Del Marous, Trebec Excavating Co., Euclid, Ohio

You'll be hearing more and more statements like these as more and more operators discover the surprising and extremely easy operation of the new Thew-Lorains in the ½ and ¾ yd. classes. An entirely new idea in the operating controls of these machines has reduced operating effort by as much as 70% . . . plus faster machine response and higher output. But — the actual proof is in the field, where many new Lorains are swinging, hoisting and moving so much easier and faster that operators are putting their "OK" on them enthusiastically. If you believe a happy, satisfied operator will move more dirt and make more money for you, check with your nearest Thew-Lorain Distributor.

FAST AND EASY DOES IT
...HERE'S HOW!

1. Streamlined levers on roller bearings.
2. Simplified linkage with anti-friction bearings.
3. New shoe clutches that require no dead-end adjustment.
4. New Hoist and Drag Shoe Clutches with spring-loaded live ends — easier to operate, reduces adjustment.
5. New clutch cones toggle-in clutches without latches or other effort than applying the hand lever.

HYDRAULIC POWER CRAWLER CONTROLS FOR . . .

6. Swing Lock.
7. Tread Locking Pawls.
8. Jaw Clutches for selection of Swing or Travel.
9. Crawler Steering.

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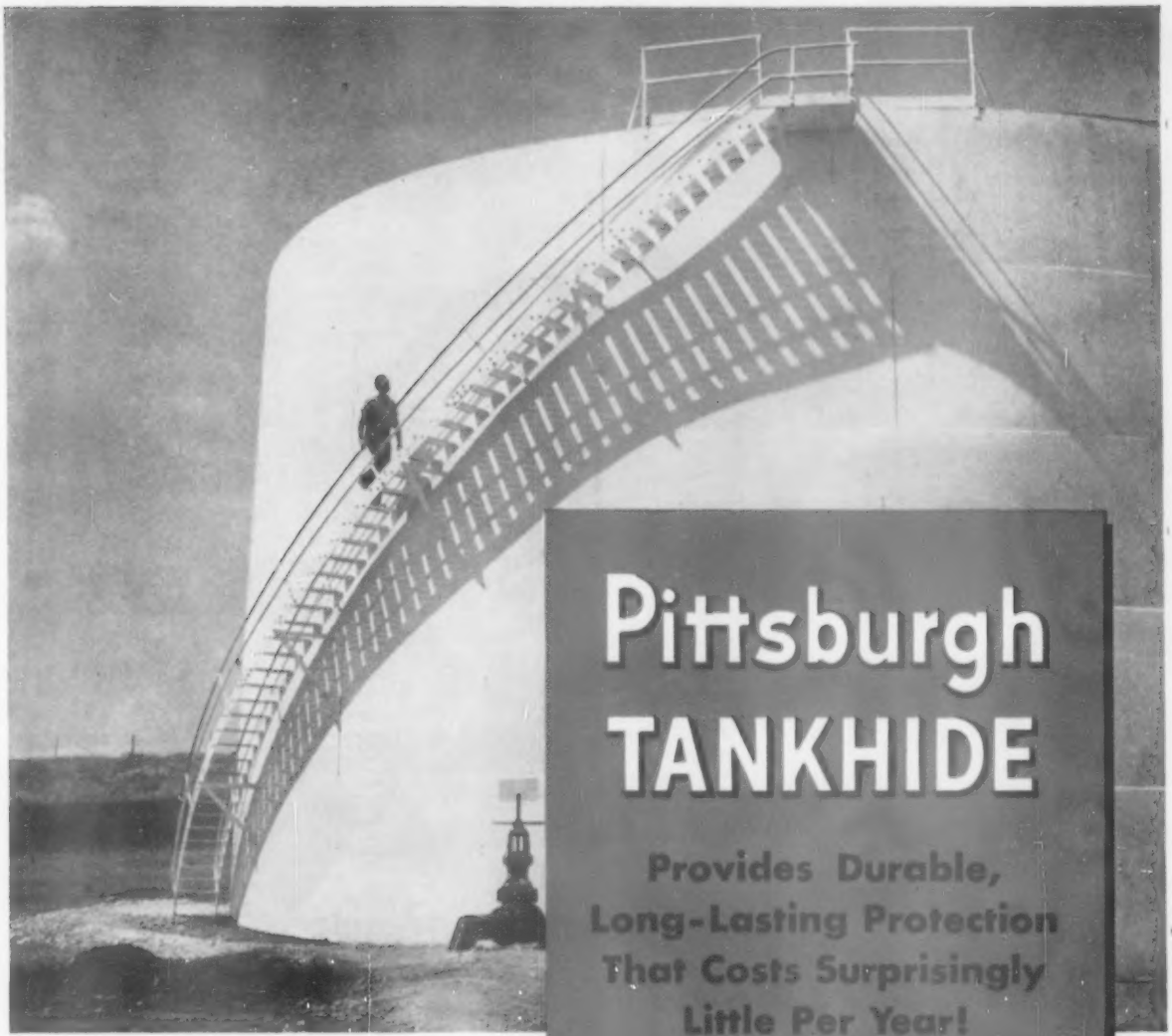
THE THEW SHOVEL CO., LORAIN, OHIO



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Provides Durable, Long-Lasting Protection That Costs Surprisingly Little Per Year!

FOR DOWNRIGHT TOUGHNESS there's no other protective coating like Pittsburgh's TANKHIDE! It's a rugged, long-lasting finish, highly resistant to corrosion and the weather. It goes on easily, dries quickly and "stays put" for enduring protection.

With its unusually high heat and light reflection characteristics, Pittsburgh's Synthetic White TANKHIDE prevents the excessive heat absorption that brings about waste by evaporation.

The brilliant white appearance of TANKHIDE is maintained throughout its long life by its self-cleaning action. The quick set and firm character of the film during the drying period prevent collection of dirt and insects . . . also keep damage from rain, scuffing and abrasion at a minimum.

Pittsburgh TANKHIDE is also available in synthetic gray and black as well as in gray and black oil-base coatings for various purposes. These can be used on wood and metal surfaces with equally good results.

Pittsburgh also provides a wide variety of quality finishes for every need in the petroleum industry. Call on us for expert advisory service. Our wide experience can often help you and save you time and money.

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PITTSBURGH PLATE GLASS COMPANY

IN CANADA: CANADIAN PITTSBURGH INDUSTRIES LIMITED

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

- No internal wearing parts.
- No valves, pistons, or vanes.
- No internal lubrication.
- Low maintenance cost.
- Saves floor space.
- Desired delivery temperature automatically maintained.
- Slugs of liquid entering pump will do no harm.
- 75 pounds in a single stage.

NASH ENGINEERING COMPANY
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Look under the hood!

On now – Truck Event of the Year –

HOODS UP SHOWDOWN!

A new type short-stroke engine design is revolutionizing truck performance. Ford, and only Ford has it in every model!

It's the automotive news of the year! First the car industry goes short-stroke V-8. Now the truck industry begins to follow suit. Small wonder! This new engine design increases piston ring life up to 53% . . . saves up to 1 gallon of gas in 7 . . . reduces engine friction as much as 33% for *more* usable power . . . gives longer engine life.

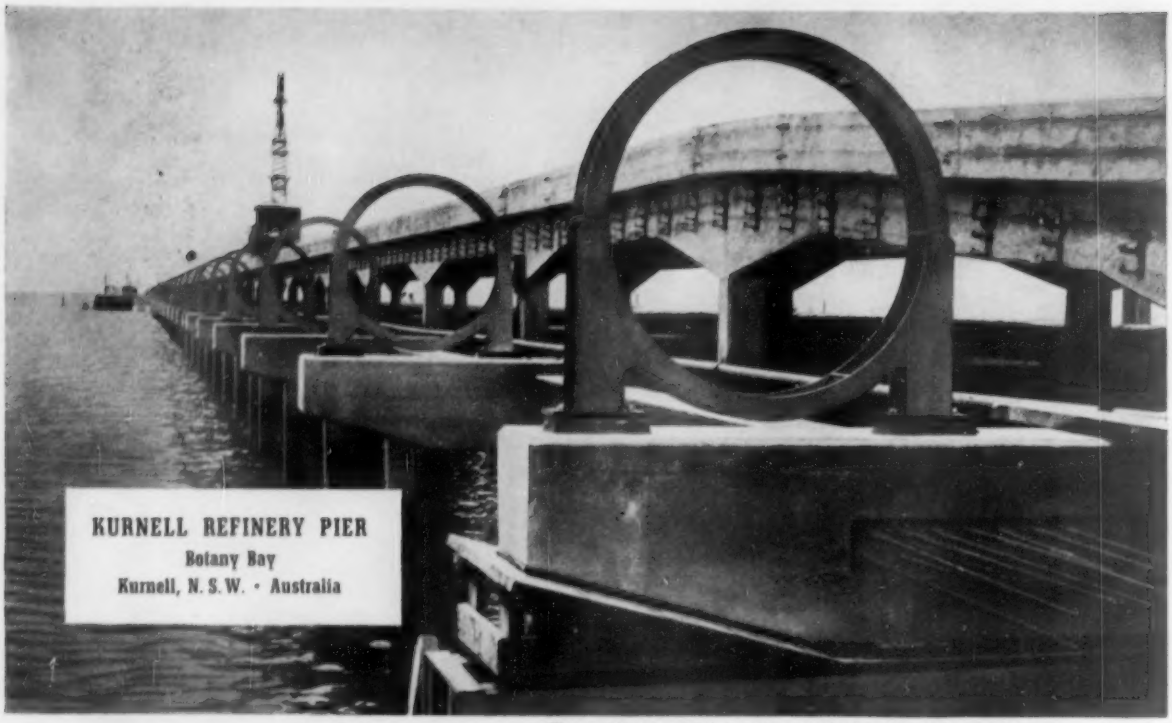
Short Stroke power to roll the heaviest loads on long or short hauls with amazing speed and economy. New Ford F-800 Big Jon with 170-h.p., Short Stroke *Cargo King* V-8. Max. GCW—48,000 lbs. Max. GVW—22,000 lbs. Power Steering at worth-while extra cost.

Ford—pioneer in V-8 truck power—has had Short Stroke V-8's on the road for three years. Today, *only* Ford offers an "on-the-job" tested, money-saving Short Stroke engine in *any* truck model you choose . . . with 4 Short Stroke V-8's and a Short Stroke Six.

Look under the hood! Be sure your next truck doesn't have an old-type, *long-stroke* engine that may be outdated before it earns its keep. Get the facts at your Ford Dealer's Hoods Up Showdown . . . now!

FORD Triple Economy TRUCKS

THE MONEY MAKERS FOR '55



The construction a joint venture of Fletcher-Merritt-Raymond under contract to E. R. Badger & Sons Pty. Ltd.

Raymond GOES "DOWN UNDER" FOR CALTEX

AUSTRALIAN OIL REFINING LIMITED a Caltex subsidiary, is one of the latest of the world's leading oil companies to turn to Raymond for specialized heavy construction work. Pictured above is a section of the 2,800 ft. approach trestle which will carry a 54" pipeline and a 15' roadway to the tanker wharf. In this venture Raymond illustrates how cooperation and the coordination of men and methods can accomplish any construction task . . . anywhere.

RAYMOND'S DOMESTIC ACTIVITIES
Foundations . . . Marine structures and Off-shore Construction . . . Heavy Construction . . . Soil Investigation.

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Complete service for all types of construction.

Raymond
CONCRETE PILE CO.

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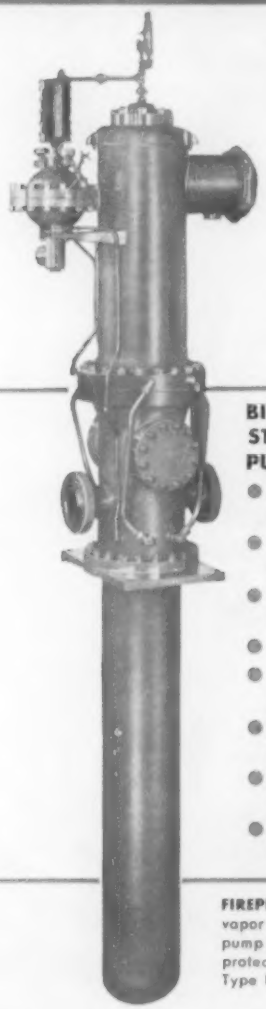
BRANCH OFFICES in principal cities of the United States, Canada, Central and South America.

Bingham STUFFINGBOXLESS PUMPS

HANDLE LIGHT HYDROCARBONS* AT HIGH SUCTION PRESSURES



NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300°).

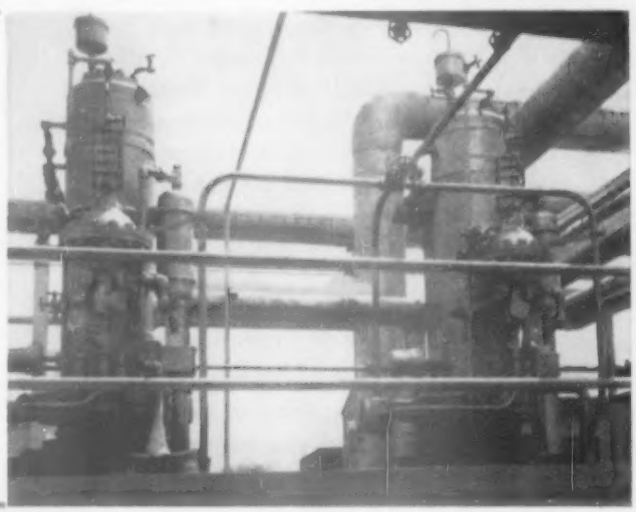
Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F. and higher also can be handled.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

*And other volatile liquids.

BINGHAM STUFFINGBOXLESS PUMPS OFFER:

- Lower overall installed cost
- Less operating attendance
- No misalignment of moving parts
- Smooth operation
- No auxiliary lubricating system
- No exposed moving parts
- Positive motor cooling
- All parts are accessible



FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor to atmosphere or leakage from outside into pump is impossible. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KT Multi-Stage Stuffingboxless Pump illustrated.

Battery of Bingham Type KT Stuffingboxless Pumps handling light hydrocarbon at low temperature, under high suction pressure. Tennessee Gas Transmission Co. plant, Gabe, Kentucky.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

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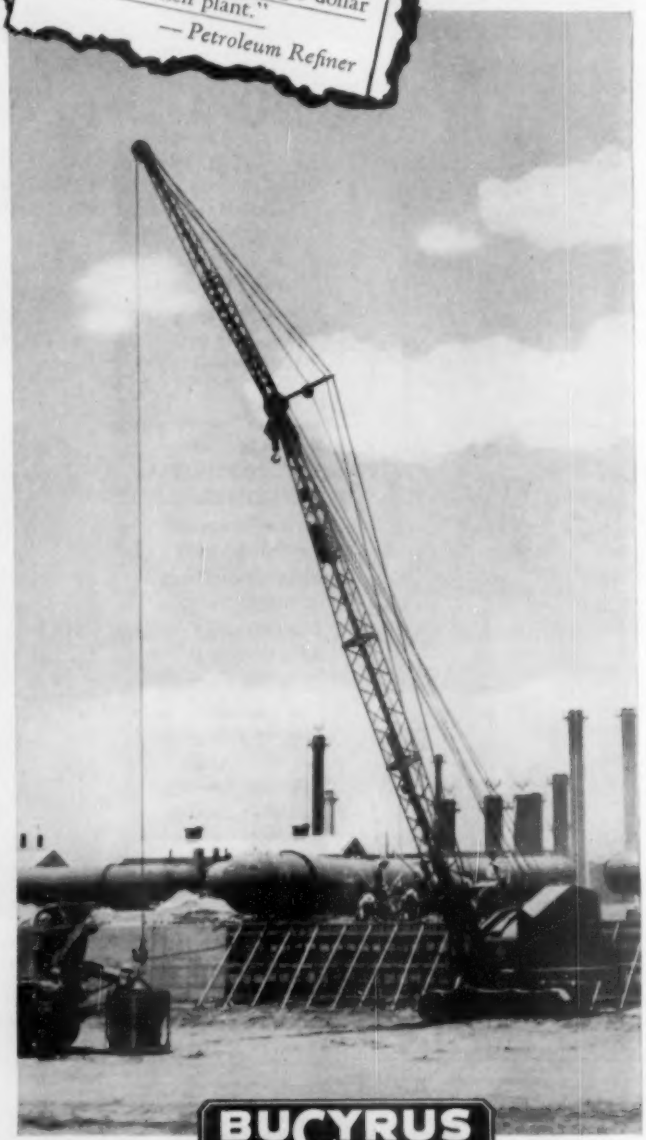
How Can We Save You Money?

"Within the last two years, alert refinery managers, through the avenues of cost analysis techniques, have discovered something they never knew before—refinery maintenance is the biggest single dollar consumer in their plant."

— *Petroleum Refiner*



For quick, dependable handling of maintenance work at lowest possible cost you'll find you're ahead with a modern Bucyrus-Erie lifting crane, like the Model 22-B shown here. At this refinery a 22-B, equipped with 45-ft. boom and 15-ft. jib extension, is pouring concrete piers for a new addition — a fringe maintenance job, but one that shows the kind of jobs this versatile machine can do so effectively for you.

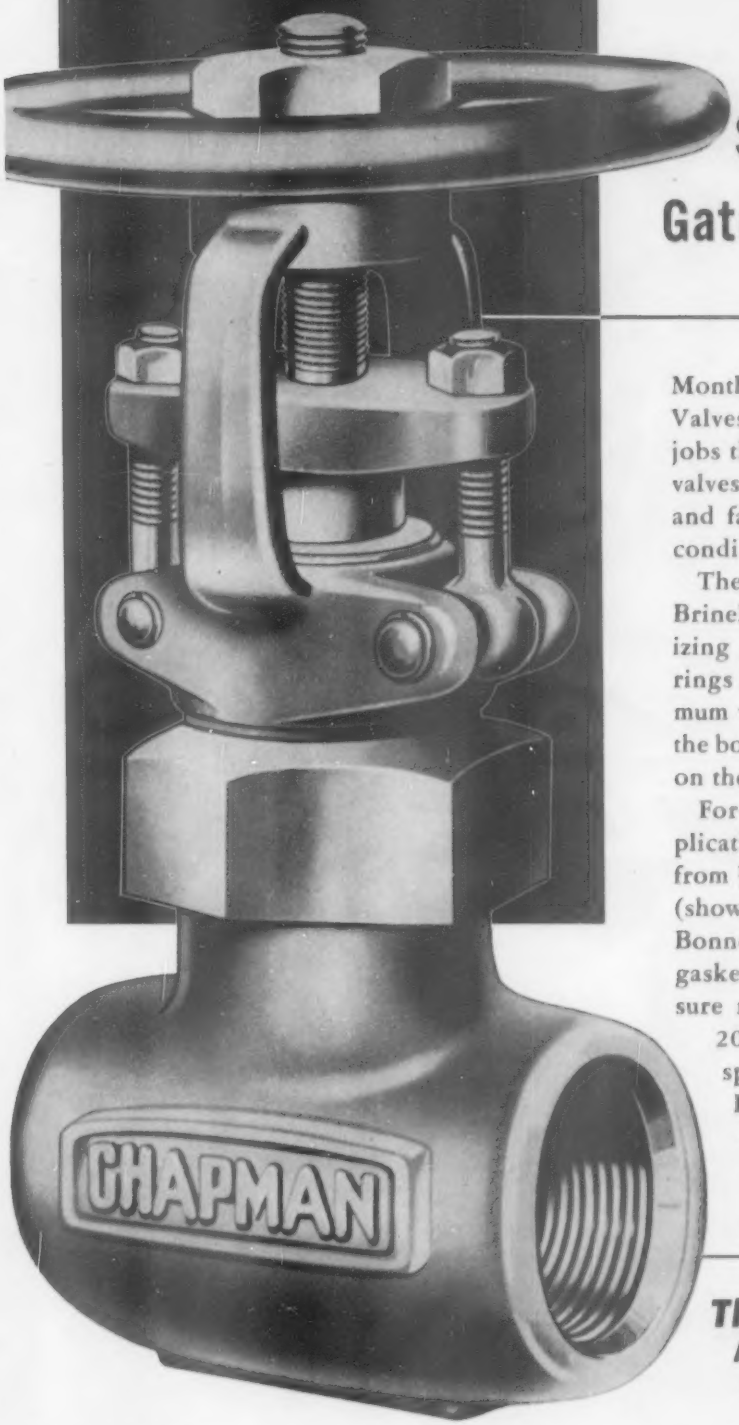
Lifting or loading jobs are easy for the speedy 22-B. Two variations of propel speed — low for ordinary moves, high for long distance travel — give it full mobility. A strong but lightweight boom, extendible to 70 feet by inserting sections, enables it to handle loads near the center of process units, eliminating the expense of installing built-in handling facilities. And boom control is accurate, reliable. The 22-B boom hoist is independent of all other functions —boom angle can be changed while the machine is swinging or propelling, while the load is being hoisted or lowered. One lever controls both raising and lowering of the boom.

It will cost you nothing to learn the many additional reasons why Bucyrus-Erie cranes can help conserve your maintenance dollars. Ask our distributor in your area for full details on the complete Bucyrus-Erie line — crawler cranes from 3- to 60-ton capacity (nominal ratings); 15-ton and 25-ton capacity Transit Cranes. 43E54

BUCYRUS ERIE

BUCYRUS-ERIE COMPANY South Milwaukee, Wisconsin

Chapman List 960



...for EVERY Small Forged Steel Gate Valve Application

Month after month, Chapman List 960 Valves deliver the goods on more different jobs than any other small forged steel gate valves. And maintenance charges are few and far between even under the toughest conditions.

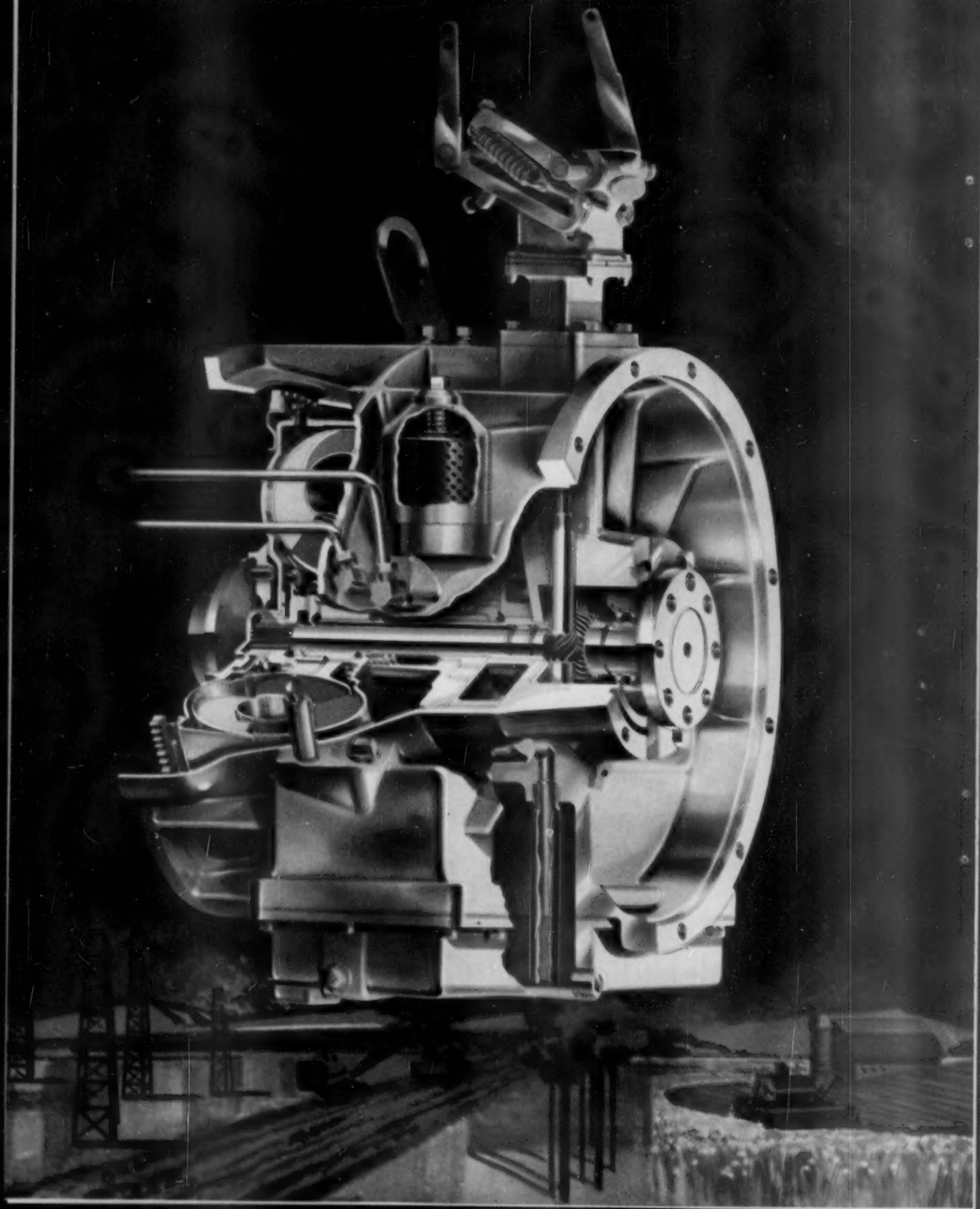
The wedge gate faces — hardened to 800 Brinell by Chapman's exclusive Malcomizing process — won't seize or gall. Seat rings are hardened stainless steel, for minimum wear, and are easy to replace. Also, the bolted follower has no exposed threads on the yoke to corrode.

For every small forged steel gate valve application, specify Chapman List 960. Sizes from ¼" to 2", either rising stem with yoke (shown) or rising stem with inside screw. Bonnet joint is ground metal-to-metal or gasketed, depending on application. Pressure range is from 380 psi at 1000°F to 2000 psi at 100°F. For higher ratings, specify List 990.

List 960 is made in various alloys and combinations of alloys as listed in Catalog No. 10. Write for your copy today.

The CHAPMAN Valve
Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS

OUTPUT UP-COSTS DOWN



with the new CHRYSLER Industrial Torque Converter

Now available for installation on Chrysler Industrial Engines

Chrysler—famous the world over for truly engineered performance—offers a New Industrial Torque Converter designed and built to fill the intermittent need for greater torque within the recommended power range . . . employed in any application.

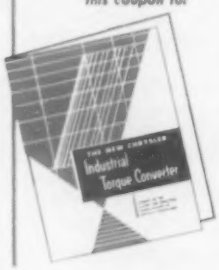
The New Chrysler Industrial Torque Converter provides torque multiplication of 2.6 with almost 97% efficiency in coupling range. For the first time here's a torque converter with provision for a *built-into-the-housing* speed control device. This feature, optional equipment, automatically adjusts torque converter speed to variations in road and load conditions, making it unnecessary to rely on less sensitive engine governor. Dual cooling, liquid and direct-air, dissipates torque converter heat faster enabling more efficient operation.

The engines powering your equipment now may lack the torque they occasionally need. Here's a way to solve that added requirement *without* installing an otherwise unnecessarily large engine. Check into these and the many other advantages of the New Chrysler Industrial Torque Converter. It's two-thirds the weight of cast iron competitive units which include provision for both transmission and power takeoff clutch. Its cost is amazingly low.

CHRYSLER
INDUSTRIAL
TORQUE
CONVERTER

PRODUCT OF MARINE & INDUSTRIAL ENGINE DIVISION CHRYSLER CORPORATION TRENTON, MICHIGAN

WRITE FOR INFORMATION FOLDER
Simply fill out, clip and mail this coupon to:



Chrysler Industrial Torque Converter
Dept. 153, Industrial Engine Division
Chrysler, Corporation
Trenton, Michigan

YOUR NAME _____

COMPANY NAME _____

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NUMBER AND STREET

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B and W Scratchers remove mud cake, and here is how to prove it

1. Run B and W Scratchers on your casing.
2. Move the casing after it reaches bottom.
3. Circulate until returns from bottom reach the shaker screen.

B and W Nu-Coil Scratcher

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THERE IT IS! . .

You will see all the evidence you need to convince you that B and W Scratchers and Centralizers have conditioned the hole . .

For a GOOD CEMENT JOB

B and W Inc.

Well Completion Specialists

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Houston 12, Texas	Los Angeles 54, Calif.
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They Say—

Advice for Alaska

Dear Sir:

During the past 2 months I have been an avid reader of The Oil and Gas Journal, which is received by the local library of Homer . . . The interest is not one of curiosity but for a specific purpose.

During the past few years, considerable interest has been shown in the Kenai Peninsula for gas and oil by several companies. In the last 18 months the entire Kenai Peninsula . . . has been blanketed by oil and gas leases by individuals, groups, and oil companies . . .

Homer is a small community with a Public Utility District as a governing body. The population numbers approximately 1,000, and the primary source of income is from fishing . . .

As chairman of the economic development committee of the Homer Chamber of Commerce, I would like to find out what . . . an oil boom will do to a small community. We are very aware that additional housing . . . will become necessary, as will various additional trades and services. Our school . . . is inadequate . . .

Perhaps a short review is in order: We have ship, air, and road transportation facilities available, local requirements for fuel oil and gas are obviously limited to the small immediate population. The demand for petroleum products . . . is increasing yearly . . .

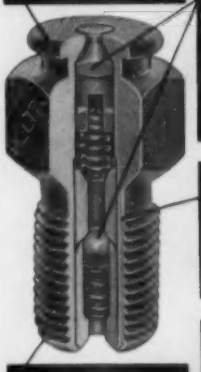
Should commercial quantities of oil be discovered in this area, is it reasonable to expect that a refinery would be constructed nearby or would it be most likely that the crude would be shipped to the United States for processing? Should the latter development occur, it appears that the only benefits that this community might expect to derive from oil discovery would be limited to the initial construction of the wells and a service pipeline for ships to pick up the crude . . . If a refinery were constructed, it seems that a larger staff would be required, and that trucking services would be inaugurated and the community derive much larger benefits . . .

The community is also faced with an increase in population due to construction of an Air Force facility described as a $4,500,000 installation, scheduled to be built this season adjacent to Homer . . .

It is believed that if the proper advance planning can be made, Homer

See WHY DELTA Grease Fittings for Lubricated Plug Valves

.... DON'T LEAK
.... LAST LONGER
.... WORK BETTER
.... ARE SAFER!



DOUBLE CHECK VALVES
Steel ball-type check valve in body. Piston-type check valve in head makes metal-to-metal seal—no gaskets to leak or wear out and cause valve button to protrude and become damaged or lock coupler on fitting.

ONE-PIECE STEEL BODY
No threads to leak or loosen. No danger of tampering or removing check valves.

15,000 lb. TEST
Type N and Type P Fittings are guaranteed not to leak under 15,000 lb. pressure.

A DELTA Fitting for ANY Lubricated Plug Valve

3 TYPES—5 SIZES
All Delta Grease Fittings are available in ⅛", ⅜", ½", ¾" and 1", with all five sizes in three standard threads, fine, coarse, and pipe thread.

The Rugged DELTA GUN

Develops 10,000 lb. pressure. Heavy barrel tested to 30,000 lbs. Fast, positive prime, handles heaviest lubricants.

Get this CATALOG
Complete information on Delta Fittings, Gun, Automatic Lubricator and DELTA-DESCO Lubricants for any valve service.

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The Only Complete Plug Valve Lubrication Company
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ALL TYPES...ANY CLASS FIRE!

Since different fire hazards require different types of fire extinguishers, PYRENE—C-O-TWO manufactures all types . . . the finest and most complete line on the market today.

When doing business with PYRENE—C-O-TWO, you receive unbiased advice on what is best for your particular fire hazards, whether class A, B or C. Also, there is a well-rounded sales engineering organization having nation-wide representation to render top quality service wherever you're located.

Don't take unnecessary chances . . . the extensive fire protection experience of PYRENE—C-O-TWO over the years is at your disposal without obligation. Get complete facts now!

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COMPLETE FIRE PROTECTION

portable fire extinguishers . . . built-in fire detecting and fire extinguishing systems

CARBON DIOXIDE • DRY CHEMICAL • VAPORIZING LIQUID • SODA-ACID • WATER • CHEMICAL FOAM • AIR FOAM

"Schoolmaster of the Oil Industry"?

One of our readers referred to The Oil and Gas Journal recently as being just that—the oil industry's schoolmaster. And frankly, our first reaction was to feel a bit uneasy.

After all, we certainly try to avoid the dull "textbook" appearance that "schoolmaster" might imply. And we go far out of our way to avoid using either the language or tone of the too-erudite professor.

But come to think of it, there's also a lot we *like* about our reader's comment. Our primary purpose *is* to inform and educate our readers. And we *do* make every effort to give our editorial material the same technical accuracy, authority, and lasting significance that's inherent in good technical education.

We'll even go so far as to say that perhaps we subconsciously *try* to be the "schoolmaster of the oil industry"—schoolmaster in the image of a competent, interesting lecturing professor who gives his audience the best of his subject in a way that communicates it most effectively.

We *try* to choose the technical news and know-how that represents the best thinking of the oil industry each week.

We *try* to write that material simply, clearly, and effectively so that the important industry information we present isn't obscured by technical jargon or complex phraseology.

And we *try* to present and illustrate that material in the same simple, clear, effective way. Not "beautified" with glaring, misused color or made "clever" by tricky, complex layouts. But with one thought in mind: to transmit to the mind of the reader—in the fastest, most interesting way—the important information we offer.

In short, maybe we *have* tried to be the "schoolmaster of the oil industry." And if so, have we succeeded? Have we managed to walk the tightrope of balance between the stodgy and the vividly empty, the shallow and the too-deep?

Luckily, we have a way to answer these questions—our renewal percentage. The per cent of our readers who've taken our "course" and reenrolled for another year.

That percentage, for The Oil and Gas Journal, is about 85. We like to think that's fair proof that if we *are* the "schoolmaster of the oil industry," our "students" think we're a pretty good prof.

The PETROLEUM PUBLISHING COMPANY
211 So. Cheyenne • Tulsa, Oklahoma

ALSO *PUBLISHERS OF:* PETROLEO INTERAMERICANO *and* OIL AND GAS EQUIPMENT

will be able to adapt itself to whatever changes may come along and avoid many of the growing pains other communities have suffered due to lack of such planning.

Whatever assistance you may be able to furnish to this end should merit the deepest appreciation of all citizens in this community.

Homer S. Thompson
Chairman Economic
Development Committee
Chamber of Commerce
Homer, Alaska.

Editor's Note: Reader Thompson outlined a very interesting oil situation that might be possible for Homer, and you are correct in your concern for "advance planning" in case a considerable oil activity develops.

The speed of development and number of people crowding into Homer would depend on the size of a discovery well, prospects for production and development, and the number of companies having leases nearby. If one or two companies have a big block of acreage around a discovery well, the development will be slow and orderly. If the acreage is cut up among many operators, there could be a hectic drilling rush to drill offsets and prove up leases before expiration.

If there is a big development, major companies probably would have their division offices at Anchorage. Homer probably would have field offices and supply stores.

There is very little or no chance of a refinery being built at Homer, no matter how much crude may be discovered on the Kenai Peninsula. The days of small refineries near oil fields are past. It is cheaper to haul crude to a refinery than to haul away the various refined products. Refineries are located where there is good distribution by water, rail, and highway for the many different products of a refinery. In the case of Kenai production, a refinery probably would be located at Anchorage. Crude would be shipped by tanker from Homer to an Alaska refinery or to the United States.

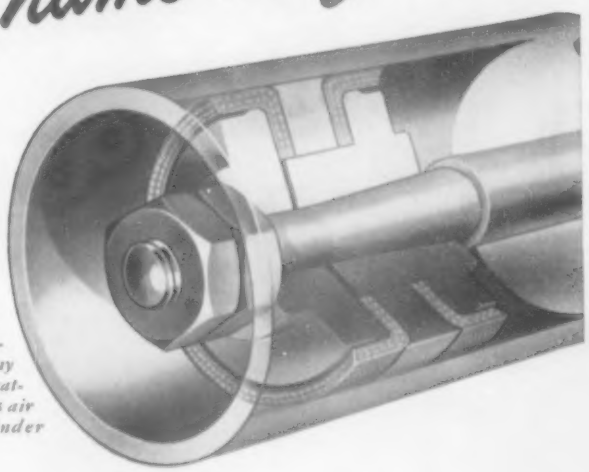
Southern Pacific's Line

Dear Sir:

I have read with considerable interest the editorial, "Sunset Limited Hits the Switch," appearing on page 71 of the February 28 issue of your magazine.

The mere fact that this is the first instance where a railroad has decided to enter the pipeline field is worthy of special mention. I do not agree, however, with your statement: "If this pipeline is built and operates successfully, it will be the first time that such

You name the fluid...



Phantom cutaway showing typical Pumcup-piston assembly—one of many types for all reciprocating pumps as well as air or hydraulic cylinder mechanisms.

Here's how to pump it at lower cost!

IN thousands of plants, Darcova Pumcups are solving the problem of diminishing pump efficiency, repacking, maintenance, down-time, lost production—the things that really eat up dollars in fluid-handling operations!
Here's why . . .

1. Darcova composition Pumcups not only increase volumetric efficiency, but they *keep* it high with no appreciable fluid slippage for the entire life of the Pumcups.
2. And, because of their design, composition, and operating principle, Pumcups have *many times the life* of most other types of piston packing.
3. Based on years of application research, Pumcups come in standard and special compositions for exceptional stability in handling almost *any* fluid you can name. For example . . . strong acids and alkalies, food products and even the most troublesome petroleum derivatives.

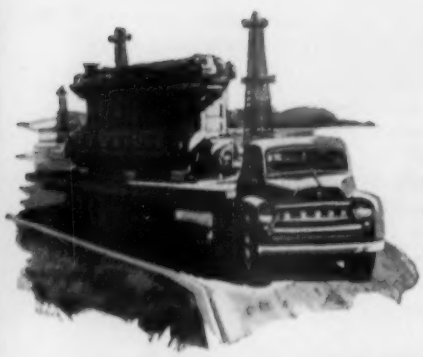
Big savings? We'll gladly refer you to Pumcup users whose problems are similar to yours. *They'll* tell you! Meanwhile, send for a free bulletin containing helpful, more detailed information· Bulletin 4401 on Pumcups for reciprocating pumps; Bulletin 4502 on Pumcups for air and hydraulic mechanisms. Just write to . . .

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT 1, PA.

DARCOVA
THE ORIGINAL COMPOSITION CUP
PUMCUPS

This is the "Torture Chamber"... Here TDA proves axle quality!

An axle is picked out of stock—then subjected to such tests as a simulated "chuckhole" shock every 4 seconds, 24 hours a day for months! Or a "bend test" on an axle housing for 1,000,000 cycles. Or an axle shaft "twist test" of 14° backwards and forwards 36 times a minute, 24 hours a day, days on end. We even simulate 500,000 miles of the toughest driving situations in just a few days—or invent a test like driving uphill with a full load from California to New York nonstop! *There's no other testing like it!*



WE HIT 648,000

in the famous, one-and-only indoor proving ground!

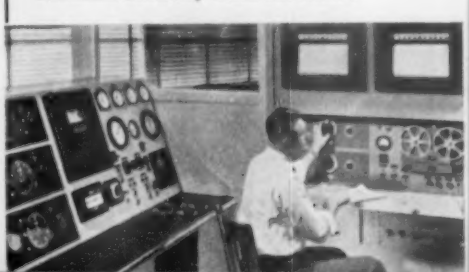
We give axles a merciless beating! Equal the worst possible operating conditions. Then throw in some devilish tests of our own!

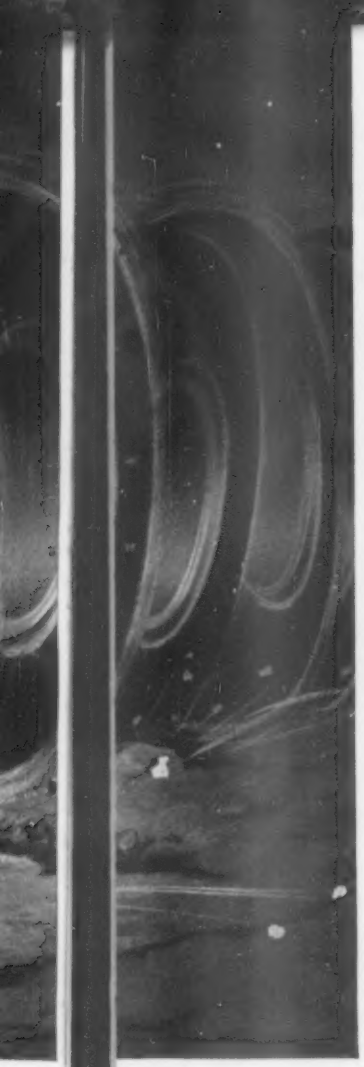
It's without equal! Nowhere else does such murderous torture show you *in advance,* how an axle is built to stand it on the job!

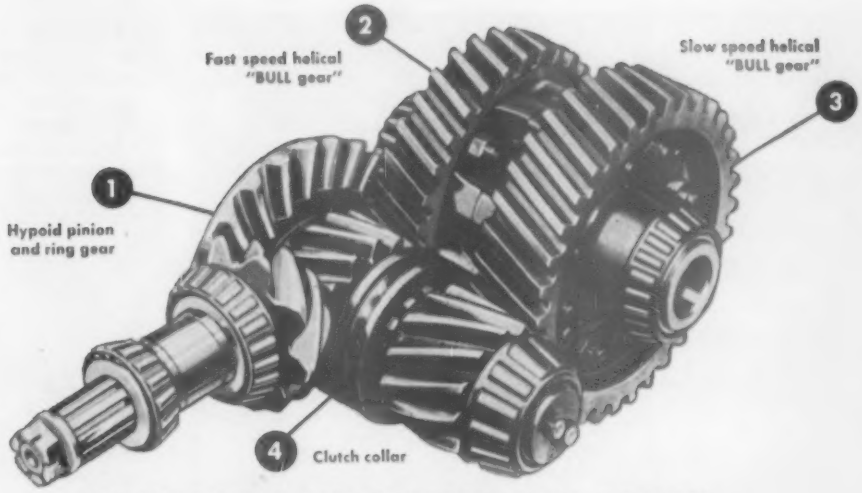
We've condensed a multi-thousand acre proving ground into one room in the Timken-Detroit "Torture Chamber." Here, our engineers can put over 50 years of experience to work for you—unsurpassed experience, obtained in building axles for all types of trucks, buses, trailers, farm machinery. Here, we can give stock axles and gearing "the works" *indoors,* to any *outdoor* operating condition—under scientific control and analysis.

How do you benefit? In longer axle life, less maintenance, repairs and downtime; lower operating costs. That's why Timken-Detroit axles are the choice of leading manufacturers and operators.

Meet our "Torture Tester"! With graphs showing speed and torque performance under any operating conditions he chooses—with special dials, recorders and electronic devices—he actually *drives* axles with scientific accuracy from his chair!







EXCLUSIVE DOUBLE-REDUCTION DESIGN...

gives TDA 2-speed axles far greater gear ratio "spread"!

Unequalled Flexibility! Only Timken-Detroit 2-Speed Axles are available in *three* different ratio "spreads" to meet any transmission-engine combination: 28%, 37% or 49%. Unlike ordinary designs that are limited to 37%, this Timken-Detroit Axle selection may be obtained simply by changing the low speed helical gear set.

How TDA 2-Speed Principle Works: A husky hypoid ring gear and bigger, stronger pinion set (No. 1 above) provides the *first step* of the total gear reduction for both fast and slow ratios. Two large, heavy-duty helical gear sets provide the *second step*. Both sets are of balanced size and capacity. One set (No. 2) is for fast speed—the other (No. 3) is for slow speed. The clutch collar (No. 4) moves to left or right to engage one helical pinion or the other. The helical pinion not in use idles.

The Result: Complete elimination of small, complicated parts and midget-size gears! Larger hypoid-helical design gives more teeth in contact—reducing load per unit of contact area—for more positive, quiet operation. Bearings are larger. There's longer engine and truck life. When you divide the total gear reduction, you double its life expectancy. TDA gears operate in either ratio *indefinitely* without overheating.

"CHUCKHOLES" A MONTH

Timken-Detroit Axle

TIMKEN Detroit AXLES

TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted TDA Standard

TRADE MARK REGISTERED

"TORTURE-TESTED"
to Save Money on the Job

World's Largest Manufacturers of Axles for Trucks, Buses and Trailers

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania

New TDA brake shoes save up to 40 lbs. per axle

• Lightweight, pressed steel construction to give you more payload plus long wear and safety. Exclusive ¾" TDA "Econoliner" brake liners held rigidly by 12 deep set rivets per block —*not bolts*. Liners are thickest at center where greatest wear occurs—taper down at ends. Result—longer wear, greater stopping ability. New cam roller mountings never seize or brinell. Light nylon camshaft bearings wear up to 4 times as long!

More than a mere pipe fitting!
catawissa
PERFECT SEAL
unions
give a 3 to 1
safety factor
PLUS
A PERFECT SEAL!
THERE'S A CATAWISSA PERFECT SEAL UNION FOR EVERY USE . . . ALL TEMPERATURES, ALL PRESSURES!
The full dependability of HOT FORGED STEEL is yours in a Catawissa Union (hot forged from solid steel bars) with several extra value features that are exclusive here at the UNION SPECIALISTS!
All Catawissa Unions are designed to give a 3-to-1 SAFETY FACTOR . . . 3,000-lb. service unions are tested to 9,000-lbs., 6,000-lb. service unions tested to 18,000-lbs., etc.
Exclusive Ball-to-Angle seat design assures a PERFECT SEAL even when the pipe is not in alignment!
Machining operations assure a UNIFORMITY AND ACCURACY heretofore found only in special fittings and, with rigid inspection both during and after machining, guarantees LEAKPROOF CONSTRUCTION!
Satisfaction is guaranteed in any application—whether it be general low pressure service or extremely high pressures and temperatures (for air, oil, gas, chemicals, hot oils, gases or steam).
WRITE FOR CATALOG 11
AVAILABLE FROM LEADING INDUSTRIAL SUPPLY FIRMS
CATAWISSA VALVE & FITTINGS COMPANY
450 MILL ST. ★ CATAWISSA, PA.

a project has been put over by anyone completely outside the oil industry—the first real 100 per cent common-carrier products line with no shipper-owner tie-ups" . . .

I would like to call your attention to the Buckeye Pipe Line Co. This company for nearly 50 years has been independently owned and operated and the entire movement of oil, both crude and refined products, is for parties having no interest in the company . . .

More recently other companies not affiliated with oil companies have constructed petroleum pipelines and apparently are currently operating successfully. I have in mind the Augusta, Kaneb, and Oil Basin pipeline companies, all independents transporting refined oils for all parties desirous of using the facilities . . .

Gordon C. Locke
Executive Secretary
Committee for
Pipe Line Companies
Washington.

Editor's Note: We are glad to accept Reader Locke's information. However, the next paragraph of the editorial said: "Every pipeline built to date has been backed by people who had oil to sell, refineries to feed, or markets to serve."

CALENDAR

MARCH

23-24 Pacific Coast Gas Association, accident prevention conference, Santa Barbara, Calif.

23-25 American Petroleum Institute, Division of Production, Mid-Continent District, Herring Hotel, Amarillo, Tex.

26 North Texas Oil and Gas Association twenty-fifth annual meeting, Wichita Falls, Tex.

27-29 Texas Independent Producers and Royalty Owners Association, ninth annual meeting, Hotel Texas, Fort Worth.

28-30 Western Petroleum Refiners Association, 43rd annual meeting, Plaza Hotel, San Antonio.

28-31 American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Exploration Paleontologists and Mineralogists, annual meeting, Hotel Statler, New York.

28-April 1 American Society for Metals, 9th western exposition and congress, Pan American Auditorium, Los Angeles.

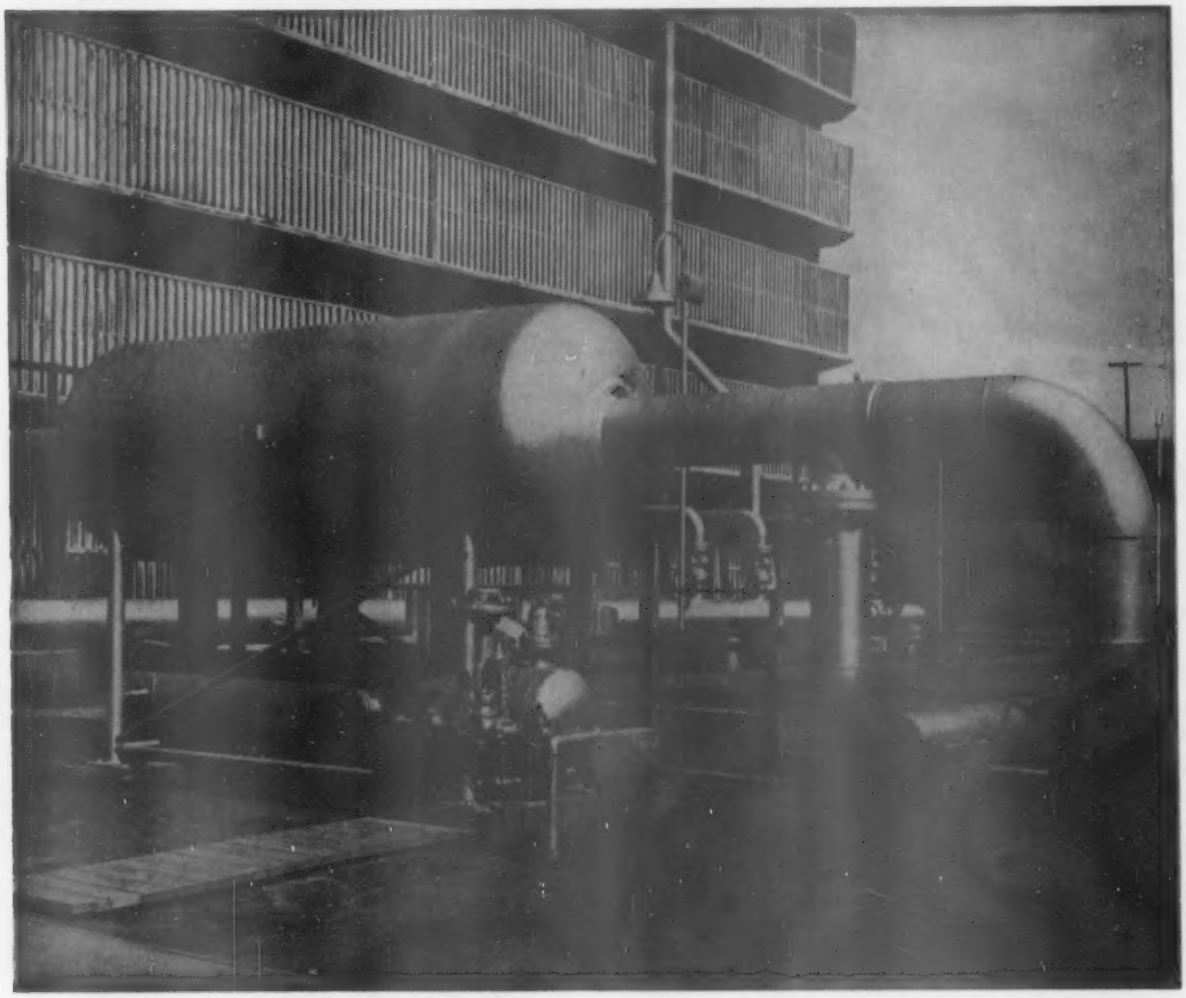
30-April 1 17th annual American Power Conference, sponsored by Illinois Institute of Technology, Sherman Hotel, Chicago.

APRIL

4-5 Wilcox Trend Symposium, Eighth Oil Recovery Conference, Texas Petroleum Research Committee, Texas A. & M. College, College Station, Tex.

5-7 Corrosion control short course, sponsored by University of Oklahoma and Central Oklahoma Section of National Association of Corrosion Engineers,

See PEERLESS FIRST!
For GAS SCRUBBERS...



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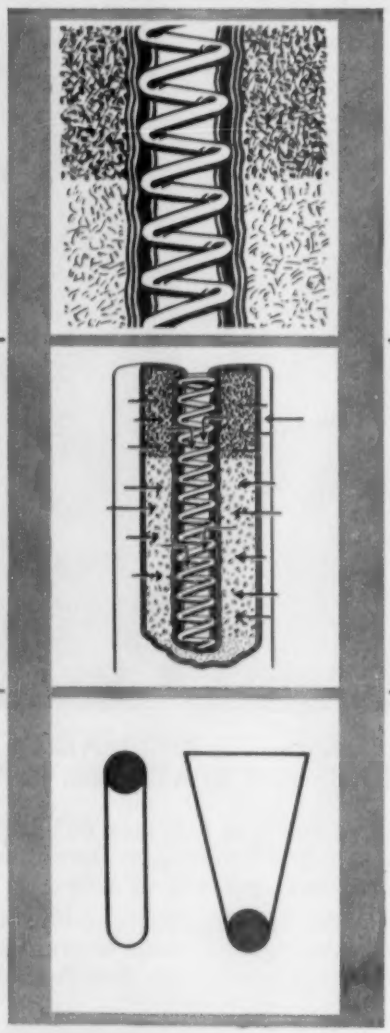

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The CP* design of progressive filtration. A "V" shaped arrangement of the filtering media which traps smaller and smaller particles as the oil progresses toward the core of the element. This construction increases the efficiency and life of the element.

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WINSLOW FILTERS **CP is fully protected by patents and trademarks*

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University of Oklahoma Extension Study Center, Norman, Okla.

13-15 Rocky Mountain District, American Petroleum Institute, Division of Production, Gladstone Hotel, Casper, Wyo.

13-15 Natural Gasoline Association of America, annual convention, Baker and Adolphus hotels, Dallas.

13-15 American Society of Lubrication Engineers, tenth annual meeting, Hotel Sherman, Chicago.

13-15 National Petroleum Association, 52nd semiannual meeting, Cleveland Hotel Cleveland.

18 Illinois Oil and Gas Association, 10th annual meeting, Mt. Vernon, Ill.

18-20 American Society of Mechanical Engineers, spring meeting, Lord Baltimore Hotel, Baltimore.

19-20 Pacific Coast Gas Association, distribution conference, Phoenix.

19-21 Southwestern Gas Measurement Short Course, North Campus, University of Oklahoma, Norman, Okla.

19-22 Vancouver Section, National Association of Corrosion Engineers, corrosion short course, University of British Columbia campus, Vancouver.

20 American Society for Testing Materials —DCC, Kansas regional group meeting, Broadview Hotel, Wichita, Kans.

20-22 Petroleum Industry Electrical Association, annual conference, Shamrock Hotel, Houston.

24-27 American Society of Mechanical Engineers, Region VIII engineering conference, Rice Hotel, Houston.

25-26 Independent Petroleum Association of America, midyear meeting, San Antonio.

28-29 American Petroleum Institute, Division of Production, spring meeting of Pacific Coast district, Statler Hotel, Los Angeles.

28-29 Refining Committee, Rocky Mountain Oil and Gas Association, annual meeting, Cosmopolitan Hotel, Denver.

29-30 American Association of Petroleum Landmen convention, Hilton Hotel, Fort Worth.

MAY

1-4 Liquefied Petroleum Gas Association, annual convention, Conrad Hilton Hotel, Chicago.

1-4 American Institute of Chemical Engineers, Shamrock Hotel, Houston.

9-10 American Gas Association, Gas Supply, Transmission and Storage Conference, Hotel William Penn, Pittsburgh.

9-11 10th Purdue Industrial Waste Conference, Memorial Union, Purdue University.

9-12 American Petroleum Institute, Division of Refining, midyear meeting, Jefferson Hotel, St. Louis.

11-12 Pacific Coast Gas Association, gas supply and transmission and conference of technical session, Palm Springs, Calif.

11-13 American Petroleum Institute, Division of Production, Eastern District spring meeting, William Penn Hotel, Pittsburgh.

12-13 Sixth Symposium, "Automation—Engineering for Tomorrow," School of Engineering, Michigan State College, East Lansing, Mich.

12-19 Sixth Latin American Congress of Chemistry, Caracas, Venezuela.

14-22 World Wide Chemical Plant and Equipment Exposition and Congress, Frankfurt, Germany.

16-18 American Petroleum Institute, Division of Transportation, products pipeline confrence, Edgewater Beach Hotel, Chicago.

16-18 Southern Gas Association, New Orleans.

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Gorman-Rupp self-priming centrifugal pumps are especially designed to meet the toughest requirements. The Pelican has many useful applications around a lease and -- it challenges any pump its size and type to equal its performance -- it never quits.

Gorman-Rupp pumps are the Quickest Priming, Highest, Priming, Fastest Pumping and Most Reliable pumps available.

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The Midget 1½" . . . Weight 63 lbs. . . . . 5,850 G.P.H.
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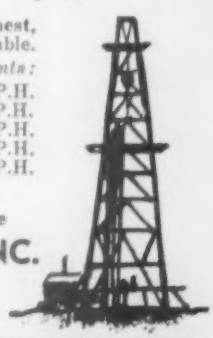
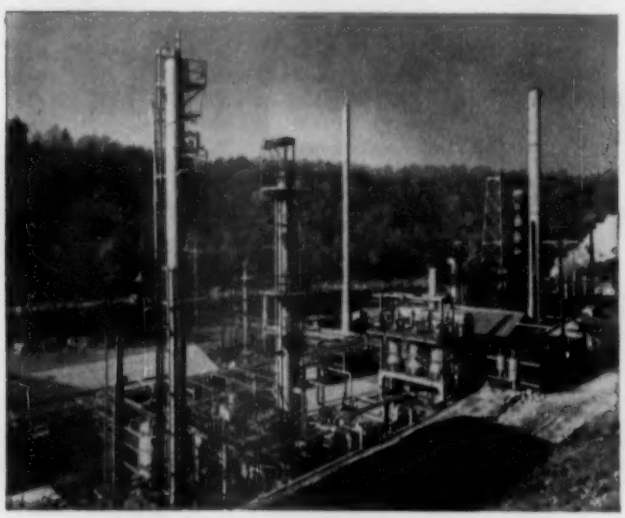
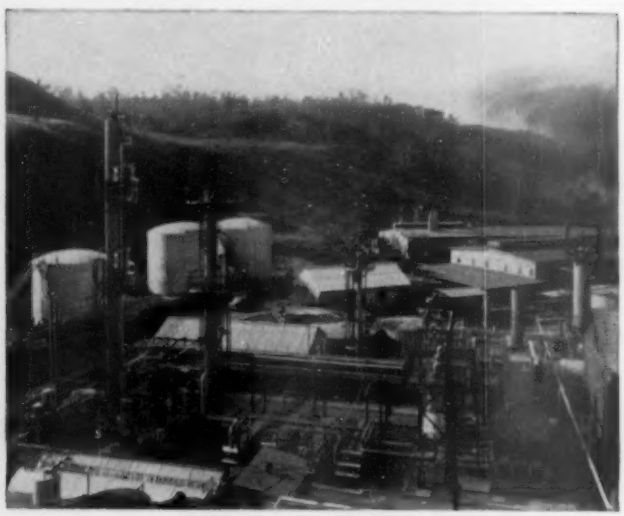


THE GORMAN-RUPP COMPANY
MANSFIELD, OHIO

Standing out in bold relief are the reactor-heater section (left) and compressor house of the 1,500 barrel per day UOP Platforming unit — the largest of three built for Quaker State Oil Refining Corporation — at the company's Farmer's Valley, Pa., refinery.



The Allegheny River is only a stone's throw from the Platforming unit at Quaker State's refinery at Emlenton, Pa. The unit has a daily capacity of 1,000 B/SD.



Rolling hills loom behind the 1,000 barrel per day Platformer at the St. Marys (W. Va.) refinery of Quaker State. The unit is a duplicate of the one at Emlenton.

Three UOP Platforming Units Solve Pressing Octane Problem For Quaker State Oil Refining Corp.

By Guy B. Hunter
Executive Vice President
Quaker State Oil Refining Corporation
Oil City, Pennsylvania

OUR company recently concluded a three-way program of product improvement which was highlighted by the installation of three UOP Platforming units, thus giving Quaker State Oil Refining Corporation the distinction of being the first independent refiner to build three of these units at one time.

Guy B. Hunter

Quaker State for more than half a century has been world renowned for its lubricating oils. Its gasolines, distributed under the brand name of "Sterling," have enjoyed an equally high reputation in the marketing areas of our three refineries at Farmer's Valley and Emlenton, Pa., and St. Marys, W. Va. The English pound sterling sign, symbol of our gasolines, always has been the motorist's assurance that he was purchasing the highest quality motor fuels that the petroleum refining industry was able to produce.

We experienced little or no difficulty in meeting octane requirements as the trend moved upward toward more powerful gasolines, but as the level approached 93 we were confronted with a serious problem because our thermal cracking equipment could not be operated economically above that figure. It was therefore apparent that if "Sterling" gasolines were to continue their leading position, another way must be found to increase our octanes.

Planned for the Future

We not only had the immediate problem of producing a higher quality motor fuel but we, like so many other independent refiners, also had to "take out insurance" against the day when octane levels would be still higher. A thorough study of the catalytic reforming field convinced us that the UOP Platforming process was indeed the answer to the situation and would give us an ample octane potential cushion for the future.

We based our decision to install Platforming at all of our refineries on four major factors which were, briefly, the commercially proved experience of Platforming; the proved reliability and the many years of satisfactory service we received from Universal Oil Products Company; the high degree of market flexibility which the process would give to our operations, and the conviction that we would be equipped to meet all anticipated octane increases in the foreseeable future.

Operation of the three Platformers has convinced us that our selection was a wise one. "Sterling" gasolines now are among the highest octane motor fuels available in our marketing areas, which are concentrated through the heart of the Allegheny Mountains in Western Pennsylvania and along the upper reaches of the Ohio River in West Virginia. Additionally, through Platforming, we have been able to increase substantially our overall cracking capacity by utilizing existing thermal reforming equipment for more extensive cracking service.

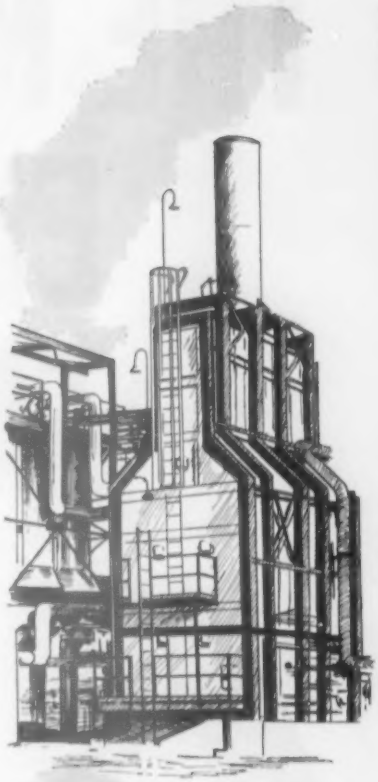
Full Boiling Range Gasoline

Quaker State is among the first to produce a 98 leaded octane Platformate. Furthermore, when the unit at Farmer's Valley went on stream, it marked the first time that a Platformer in the Eastern part of the United States was operating on full boiling range gasoline.

The same type of charge stock is fed to the Platforming units at Emlenton and at St. Marys. It boils in the range of 80° F. to 400° F., and it is low in naphthene content. Despite the fact that the feed stock contains an unusually high contaminant concentration, special provisions in the design of the units have enabled us to maintain satisfactory operations at the desired octane number.

We are more than satisfied with the operation of our three Platforming units, which give us a daily capacity of high quality gasoline as follows: 1,500 B/SD at Farmer's Valley and 1,000 B/SD each at Emlenton and St. Marys. From the standpoint of economics, we are pleased to report that Platforming has made it possible for Quaker State to produce 98 leaded octane gasoline at a yield of 81.8 per cent as against our previous operations by which we produced a 93 leaded octane product at 72 per cent yield.

(Advertisement)



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★ Equipped with positive operational checks for assurance of accurate performance

★ Can be supplied with *automatic switches* for selecting proper resistance in averaging temperature instruments.

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19-20 Society of Exploration Geophysicists, 10th annual Gulf Coast meeting, Plaza Hotel, San Antonio.

20-22 Appalachian Geological Society, Virginia Geological Survey, and West Virginia Geological Survey, spring field conference, Kavannaugh Hotel, Harrisonburg, Va.

23-25 American Petroleum Institute, Division of Marketing, midyear meeting, Chase and Park Plaza hotels, St. Louis.

26-27 Western Petroleum Refiners Association, technical-industrial relations meeting, Settles Hotel, Big Spring, Tex.

26-27 American Institute of Mining and Metallurgical Engineers, Rocky Mountain Petroleum Sessions, Shirley-Savoy Hotel, Denver.

26-27 Kentucky Oil and Gas Association, annual meeting, Lafayette Hotel, Lexington.

30-June 1 Chemical Institute of Canada, thirty-eighth annual conference and exhibition, Quebec City, Que.

JUNE

1-3 Tenth annual Short Course on Gas Technology, Texas College of Arts and Industries, Kingsville, Tex.

5-9 Canadian Gas Association, annual meeting, Sheraton-Broeck Hotel, Niagara Falls, Ont.

6-9 Oil and Gas Power Division, American Society of Mechanical Engineers, 27th annual conference and engineering exhibit, Hotel Statler, Washington, D. C.

6-10 American Petroleum Institute, Division of Production, midyear committee conference, Brown Palace Hotel, Denver.

6-15 Fourth World Petroleum Congress, Rome, Italy.

7-9 National Oil Scouts and Landmen's Association, 32nd annual meeting, Banff Springs Hotel, Banff, Alberta, Canada.

9-10 Natural Gas and Petroleum Association of Canada, Royal Connaught Hotel, Hamilton, Ont.

9-10 Pennsylvania Grade Crude Oil Association, annual meeting, Hotel William Penn, Pittsburgh.

11-15 Petroleum Equipment Suppliers Association, annual meeting, Banff Springs Hotel, Banff, Alberta, Canada.

12-17 Society of Automotive Engineers, golden anniversary summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

16-18 Interstate Oil Compact Commission, Cosmopolitan Hotel, Denver.

20-23 American Society of Mechanical Engineers, semiannual meeting, Statler Hotel, Boston.

23-24 Western Petroleum Refiners Association, technical-industrial relations meeting, Broadview Hotel, Wichita, Kans.

23-26 Rocky Mountain Oil Show, Casper, Wyo.

26-July 1 American Society for Testing Materials, Chalfonte-Hadden Hall, Atlantic City, N. J.

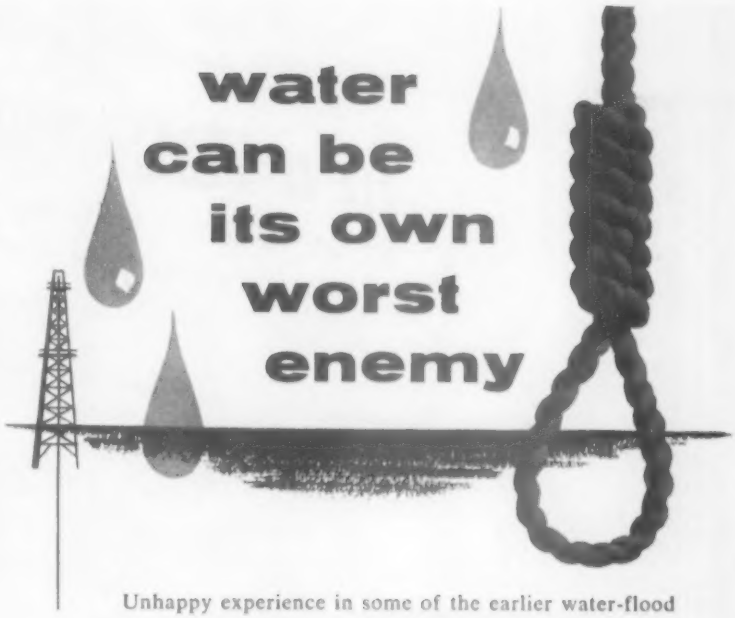
AUGUST

15-17 Society of Automotive Engineers, golden anniversary West Coast meeting, Hotel Multnomah, Portland, Ore.

SEPTEMBER

11-13 Independent Natural Gas Association of America, annual meeting, Jasper Park Lodge, Jasper Park, Jasper, Alberta, Canada.

13-24 First International Instrument Congress and Exposition, and ninth National Instrument Conference and Exhibit, Philadelphia.



Unhappy experience in some of the earlier water-flood projects has demonstrated that the injection water itself may be the very thing which defeats the project . . .because it can carry into the formation the precipitants, algae and bacteria which have been established as major causes of formation-plugging.

But, today, many of the advanced water-flood projects now in operation have no trouble at all from this source. They have installed modern diatomite filtration systems and, using Dicalite filteraids, are filtering out completely the microscopic water-borne solids which could slow or halt the water drive. That's because Dicalite filtration is so "sharp" that it traps unwanted solids even down in the sub-micron size range: up to 95% of all bacteria can be removed by Dicalite filtration.

Diatomite filtration systems take up little room – about 1/5 that required for the older, less-efficient sand filters – and their installation costs are comparatively low. In addition, diatomite filter systems can be moved to another location when and if desired; in fact, some of the newer systems are completely unitized for easy hauling.

If you'd like your water-flood project to continue at its designed input pressure, instead of watching pump pressures continue to climb, day by day—if you'd like to free your mind of at least one problem in a re-pressuring project – investigate the advantages of Dicalite filtration as used and proved by other operators. A new Dicalite Bulletin, now in preparation, covers the subject in detail . . . send in your name and we'll send you your copy as soon as it's printed.

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Welex Formation Fracturing Tool has Boosted Production in More Than 500 Wells . . .

Read these typical case histories

THE TOOL THAT FIRES AROUND A CORNER

WEST TEXAS

A Spraberry Trend well was completed with bullets in two zones – upper Spraberry sand (6,663′ to 6,667′) and lower Spraberry sand (7,524′ to 7,540′) in September, 1952. Lower sand would not break down at 5,000 p.s.i. after another bullet perforating job and finally jet perforations. Well completed in upper zone, but by mid-1954, dropped to 63 barrels per day. Lower sand was perforated at 7,534′ with *one* shot of the Welex Formation Fracturing Tool, in September, 1954. Formation then broke down at 4,750 p.s.i. and was treated with a 4,500 sand frac job at 3,650 p.s.i. *Well flowed 295 barrels of oil per day and is holding that production.*

OKLAHOMA

A well was drilled in the S. W. Mt. Vernon Pool in Teague County in June, 1954, and was a dry hole. Bullet perforating (48 shots) was attempted with no results. Well was abandoned. Re-entered in August, cleaned out below casing, and squeezed off perforations. Well shot twice with Welex Formation Fracturing Tool at 3,385′ and 3,395′. Well was not treated. *After tubing was run, well flowed 32⅔ barrels in two hours and is now testing at 116 barrels per day.*

GULF COAST

A well in the Palo Blanco field had been perforated with no results. Five shots were fired from the Welex Formation Fracturing Tool between 4,745′ and 4,805′ before fracturing with 900 pounds of sand and 240 gallons of jelled oil. Prior to these shots and treatment, well tested 5 barrels per day. *It is now pumping 99.60 barrels per day.* In the same field, Welex shot two of a group of seven wells. Before using the Tool, the wells' averages were 55 and 63 barrels. *After the shots, each well is now making 145 barrels per day.*

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The OIL AND GAS JOURNAL

TULSA, OKLAHOMA

Published every Monday by The Petroleum Publishing Co., 211 South Cheyenne Avenue, Tulsa, Okla. Phone 3-6291. Founded in 1902. Name changed to The Oil and Gas Journal in 1910 by Patrick C. Boyle.

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JOURNALLY SPEAKING . . .

They Eat it Up

THE gent in the photo above is doing what our Engineering Editor is doing in this issue—making a meal off catalyst.

Actually, he isn't really eating the stuff. This is just a publicity gag shot—cheesecake—and one of the hammiest we ever saw come out of a serious-minded research laboratory. Knowing how difficult it is to popularize scientific research, we'll keep the cloak of anonymity over the hard-pressed and overwrought public-relations man who thought this one up. What he was trying to do was to call attention to the fact that his company, in its constant quest for better petroleum products, is experimenting with all sorts and shapes of refining catalysts, including one that looks like spaghetti (but isn't, really).

But our Engineering Editor is really serving up a meal of catalyst in this annual Refining Issue. The piece de resistance is a 15-page article starting on page 184. (We admit we had to reach pretty deep to tie this up with the photo, but we were about as hard put as that press agent.)

People who understand these things tell us that this piece isn't as long-haired as it appears to be at first glance, in spite of all those squiggly formulas and Greek letters. They say it is just all about catalysis, from the Year One to date, plus a preview of the brave new world of the morrow.

Refiners and other process men will eat it up, they say, but everybody ought to munch on it some, because catalysis is the basis of practically everything that's going on around us these days. So dip into it here and there and make yourself a catalytic canape out of the more tender morsels.

(If there are any ex-GI's in the audience, we warn them not to stop at the place where the author says that the more the free energy, the greater will be the KP. He's talking about a different kind of KP. But it probably isn't stretching things very far to say that in an army camp a sergeant is a catalyst with a peculiarly effective capacity for turning free energy into KP.)

Down and Loose

IN obedience to the above injunction to get better informed about catalysis, we nibbled a bit on the page proofs of this high-powered article.

We learned that catalyst comes from the Greek words for down and loose. This stopped us for a minute, because the catalytic towers we have seen in refineries are all high and tight. However, there are things farther on that are even harder to understand, so we slid over this with the general impression that when a catalyst comes down into a situation it loosens everything up so that all sorts of things begin to happen and the final result is a whole lot different from what things were at the start.

As we get it, a catalyst is something which, by its mere presence, will cause other things to get to work, change themselves all around, and turn out some new product. (Like when the boss walks into the room). The catalyst itself doesn't do any work and none of it goes into the new product, though often it does get a bit soiled and contaminated by association with the working elements. (Say, maybe that analogy with the boss—or the sergeant and KP—isn't so far-fetched after all.)

Our author is talking about catalysis in refining, but he says the same thing happens in the human body all the time. We reckon it can happen in mental processes, too. So read this piece and see if it catalyzes your brain cells into turning out a new idea.

—Henry D Ralph.

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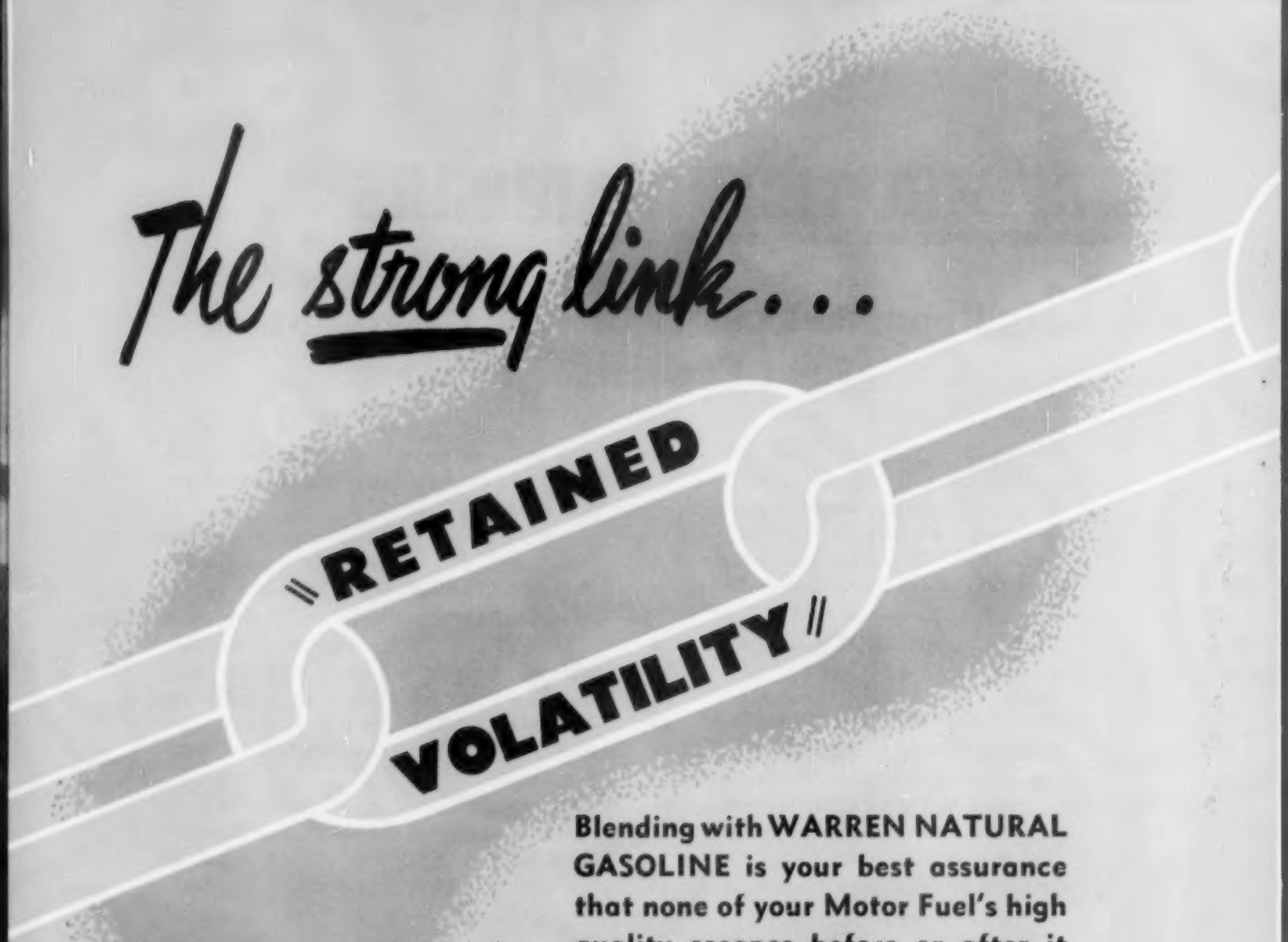

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This import quota scheme is no good

THE proposal now pending in the Senate to limit oil imports to 10 per cent of domestic demand is not in the best interests of the petroleum industry. It should be defeated.

Imports are too high and should be reduced by some means—but not by the means proposed in the so-called Neely amendment to the Trade Agreements Act.

This amendment contains a big joker—a joker that practically defeats the purpose of the producers who are working for it tooth and nail. It will do the domestic oil industry very little good. The chief benefits will go to the coal industry.

As explained in detail elsewhere in this issue of the Journal, the joker is a 10 per cent limitation on imports of residual within the over-all limitation on all oils. The result would be a very drastic reduction in the supply of resid but little more than a token cut in crude imports.

DOMESTIC PRODUCERS STEPPED INTO A BOOBY TRAP when they let the coal people draft their legislation. Perhaps they felt the need of political support from coal states, but this Neely amendment hands them the short end of the stick.

This shows the fault of political log-rolling deals. The case of domestic producers is strong enough to stand on its own feet. The producers have weakened their case by becoming a cat's-paw for coal.

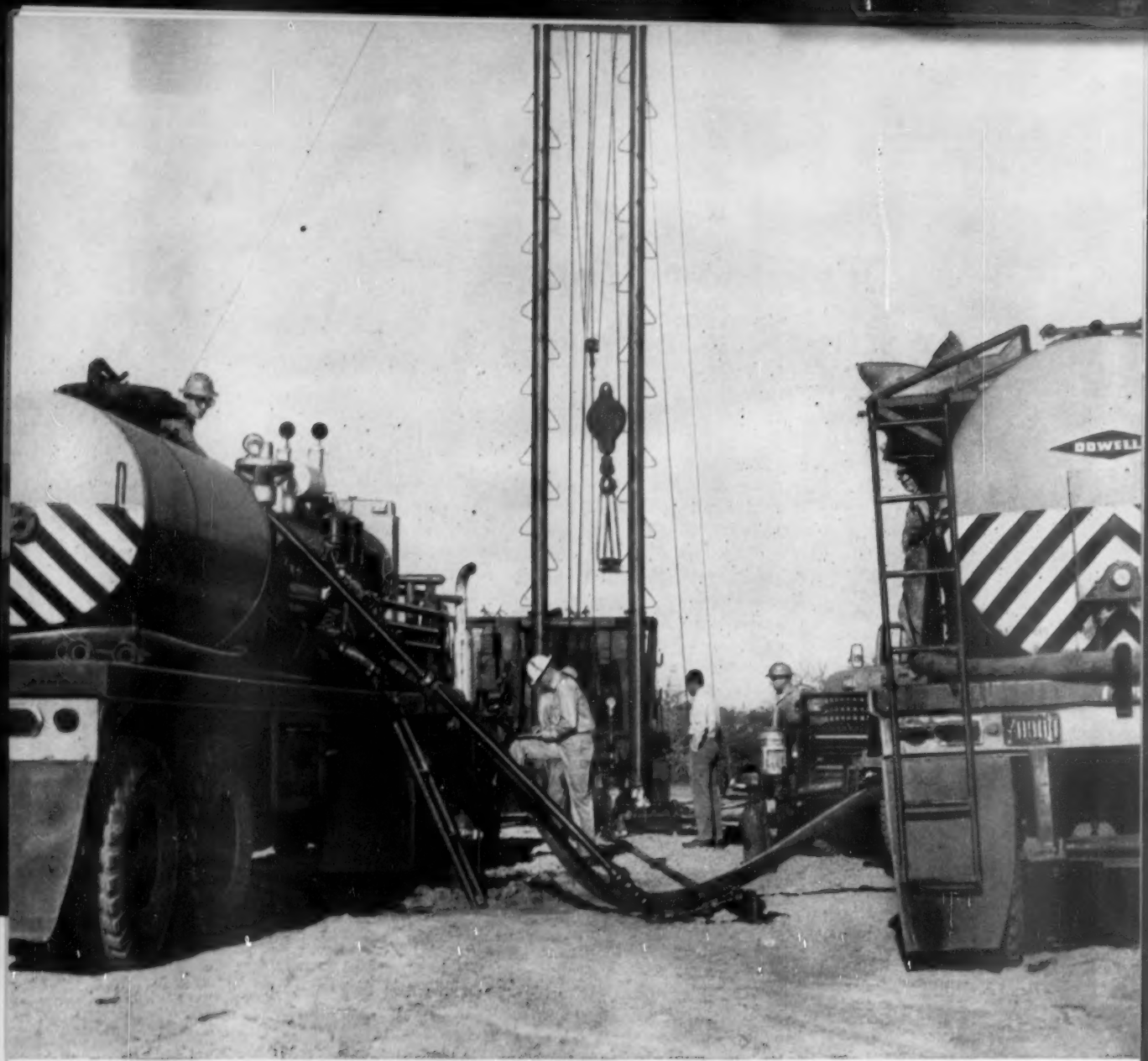
Imports of heavy fuel oil are a very minor problem to the oil industry in comparison with the real problem of high crude imports. A severe reduction in supply of resid will create more problems than it will solve, and those adversely affected will blame the oil industry.

If, for lack of a better way, oil imports are to be limited by a percentage quota, the limitation should be applied where it is needed most—that is, on crude—or broadly to all oils. Without the fuel-oil joker, the 10 per cent limitation would cut all imports about 275,000 bbl. per day below 1954, and crude would bear the lion's share of the cut.

But the Neely joker would cut crude imports a mere 66,000 bbl. per day—just about 1 per cent of current domestic crude output.

SOME RELIEF FROM CONTINUALLY MOUNTING IMPORTS of crude is needed by domestic producers and inland refiners. The Neely scheme won't help either appreciably. Producers are suckers to support it.

The imports problem won't be solved until it is solved right. Producers should devote their energies to evolving a fair and practical plan—an oil-industry plan—instead of becoming dupes for the coal industry's clever gimmick.



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THIS WEEK . . . . . IN THE NEWS

Refining

• This year will probably be the biggest single year for new developments in the refining industry. Look for new processes in cat reforming, cat cracking, and alkylation in the near future. Hydrogen treating is catching on fast.

• The whole trend in refining is toward higher product quality. There is already a letup in the growth of basic crude capacity.

• The octane curve will stay on its climb and premium gasoline will keep gaining on regular. Higher compression ratios in 1956 cars will mean a closer date for the first 100-octane premium gasoline on the market.

Exploration

• Humble will start hunting oil in new territory for the company. It plans two wildcats in the Four Corners area of Arizona.

• The deepest well ever drilled in the Appalachian area is a dry hole. It was drilled by Falcon Seaboard for Hope Natural Gas in Wood County, West Virginia. The test was bottomed at 13,331 ft.

• Sealed bids will be opened May 17 on two tracts south and southeast of California's Wilmington field. One tract will cover 876 acres, the other 550 acres. Wells will be slant holes from two piers.

Natural Gas

• Battle lines are being formed in Texas over an "economic waste" bill being studied by the Texas Legislature. Independents are backing the bill. Pipelines and big producers are on the other side of the fence.

• White House views on regulating natural-gas producers are expected to emerge this week from House interstate commerce committee hearings on the Harris-Hinshaw bill that would amend the Natural Gas Act. FPC members are expected to give the tip-off of the administration's views.

• FPC is expected to rule soon on whether escape clauses are legal.

Pipelines

• Transcontinental lets contracts for laying 36-in. pipe in a looping project on its 1,840-mile Gulf Coast-to-New York line. Contractors will include O. R. Burden, Williams Brothers, Panama Williams, Houston Contracting, Western Pipe Line, and Midwestern Constructors. Work is scheduled to begin in April.

• SEC approval of a $163 million financing plan is the only hurdle standing in the way of starting construction of Pacific Northwest's big line.

• Big Horn Pipeline Co. plans a 150-mile, 8-in. crude line from Wyoming's Ash Creek field to a Service Pipe Line connection at Midwest, Wyo.

• Panhandle Eastern asks a Philadelphia Circuit Court to take another look at the conditional FPC permit for American-Louisiana to build a line from the Gulf Coast to the Detroit area. Panhandle says it will go to the Supreme Court with its protest.

Imports

• Importers, refiners, and producers tell their story to the Senate committee holding hearings on Senator Neely's plan to limit imports to 10 per cent of domestic demand. Jersey and Gulf oppose amendment, while independent producers say it's the only way to confine imports to a reasonable level.

• Journal study indicates amendment would give oil producers only token help, but would put such a strict limit on residual-fuel imports that the price would go up enough for coal to move into fields now served by oil.

Reserves

• Proved reserves of total liquid hydrocarbons for the U. S. topped 34.8 billion barrels at the beginning of 1955, for a new high, but the net increase was the lowest ever reported by the A.P.I.-A.G.A. committee. The net increase in reserves was only 422 million barrels.

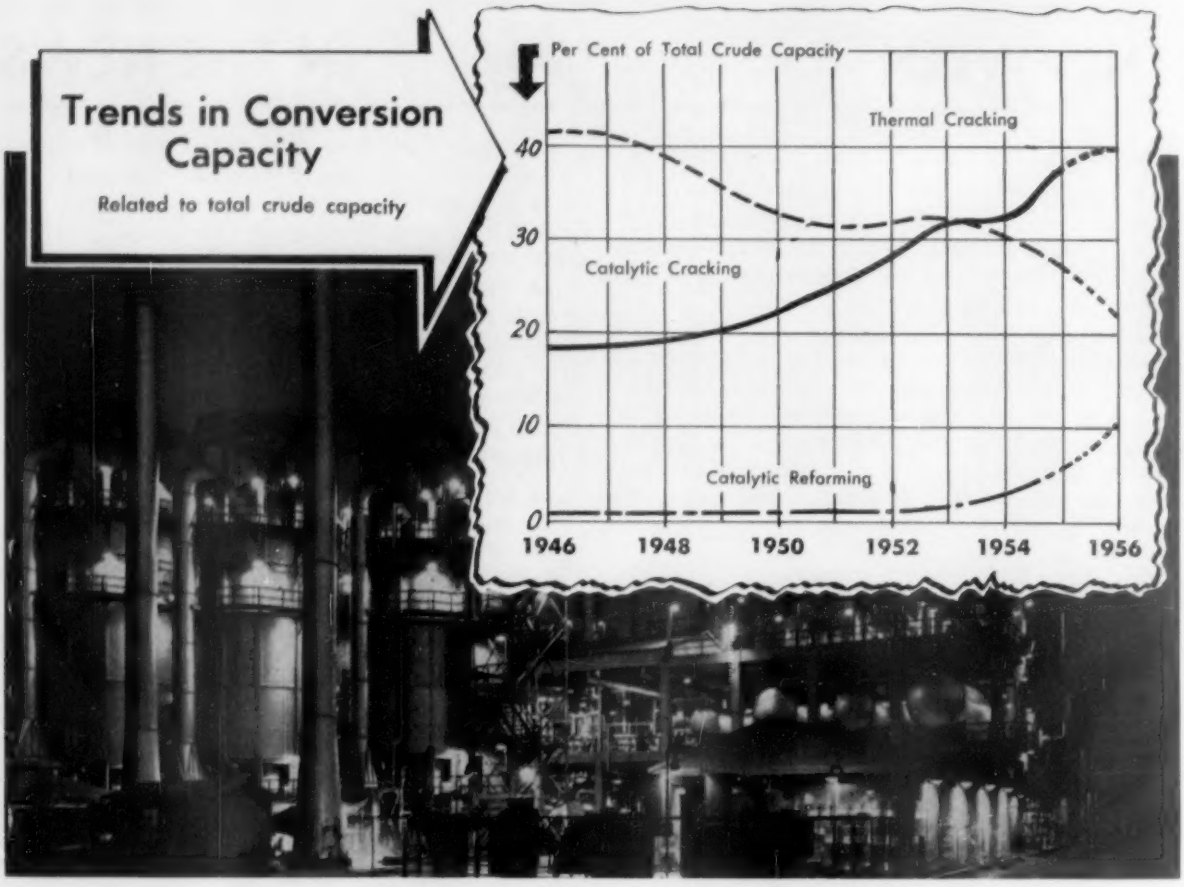
• Proved crude reserves increased almost 616 million barrels, but a net drop in natural-gas liquids of 193 million barrels held down the total. Net increase in natural-gas reserves was lowest reported in years.

International

• Jersey Standard has entered Sicily and plans to start its first well by May 1. Standard has set up an operating company with an Italian firm, Raffineria Siciliana Olii Minerali, to explore a 215,000-acre lease.

• A new headache has developed in the Iranian oil situation—splitting 5 per cent interest in the Iranian consortium among 12 American companies which have been certified to participate in the development. The companies have until April 29 to decide how to split 5 per cent.

• Greece's first refinery will be built by the government at Aspropyrgos, 10 miles northwest of Athens.



U.S. Refiners Are Going Catalytic

- **Important new developments in cat cracking, reforming, hydrogen treating, and alkylation are coming this year**
- **Big stress in today's new units is on product quality; basic crude capacity rose only 2.4 per cent during 1954**

George Weber

NEW YORK.—The year 1955 may well go down in the books with more new developments in refining than any single year in history.

We are on the eve of important announcements concerning catalytic reforming, catalytic cracking, and alkylation. Hydrogen treating is catching on fast.

The trend in refining is toward higher product quality all along the line, with a letup in the growth curve on basic crude capacity. This spells many millions of dollars in new investment, and a facing up to hard economic facts of competitive life on the part of many companies. Refiners are going to be shown the tools for making 100-plus octane motor fuels in quantity—at a price.

Not only will the octane curve continue upward, but the ratio of premium to regular-grade gasoline will increase. This means an accelerated rise in pool octane at least for the immediate future. It also means higher compression ratios for 1956 car models and a hastening of the day when some refiner will begin marketing a 100-octane premium gasoline.

Crude capacity up slightly . . . The comprehensive survey of refining facilities in this country (see pages 208 to 242), reveals a number of interesting points. For the domestic industry as a whole, basic crude capacity rose only 2.4 per cent during 1954, compared with a net increase of 12.7 per cent during 1953.

The closing of 29 refineries with 252,270 bbl. per day in crude capacity somewhat offset the new capacity added. About 75 per cent of this shutdown capacity is represented by 11 refineries closed, or about to be closed by major companies. This loss, for the most part in outmoded inland plants, was more than compensated by two new refineries and added capacity in major company refineries. As a result, the majors added about 4 per cent to crude capacity during the past year.

The smaller companies, those controlling less than 100,000 bbl. per day in refining capacity, showed a net decline of 4.3 per cent in basic capacity But this group plans to jump capacity this year by 6.5 per cent compared with a projected rise of only 0.8 per cent on the part of the majors. Next year will be another story as much of the shutdown capacity is replaced. For the present at least, independent refiners are adding the most to basic crude capacity.

If the picture on crude capacity is quiet, the reverse is true of the conversion processes required to make modern petroleum products. The present-day refinery is evolving into a giant catalytic complex, processing and reprocessing fractions to meet high quality standards. This added emphasis on chewing up crude fractions and putting them back together again revolves primarily around the five established catalytic processes: cracking, reforming, polymerization, alkylation, and hydrogen treating. One thermal process, coking, remains in the picture as processes for thermal conversion continue to fade. One further exception may be thermal reforming which shows some promise in combination with catalytic reforming.

Catalytic cracking . . . The ratio of catalytic cracking to crude capacity continues to rise. A substantial jump was registered last year, from 33.6 to 38.0 per cent. The breakdown by type is outlined in one of the accompanying tables.

Refiners are raising their sights on ultimate catalytic cracking capacity based on crude. Three factors are involved:

. . . A greater fraction of the whole crude is going to cat crackers. This is brought about by deeper residual cuts through vacuum distillation and solvent extraction, by thermal coking, and subsequent cat cracking and coker fractions.

. . . The ratio of recycle of fresh feed charged to catalytic reactors is rising. An indication of how far this trend may progress is shown in three new refineries now out of the design stage. They show total reactor feed rates of 78.5, 86.0, and 114.0 per cent of crude. The recycle - to - fresh - feed ratios range up to 1:1.

. . . Charging of the entire residual crude fraction to cat crackers is now an accomplished fact in at least two refineries. In one case the type of crude permits this practice without undue damage to the catalyst from metal poisoning. In the other, a new concept involving improvements in both catalyst and operating conditions has proved successful for a year. Information on this new development will be revealed in The Oil and Gas Journal in about 7 weeks.

Many refiners are now modifying their views on what might be done to improve the operation of the cat crackers they now have. Most have already upped capacity to the limit by removing bottlenecks in older units whose major vessels were generously designed.

The industry is highly interested in any new catalyst developments which will give them better activity and selectivity. They will be hearing about some of these improved catalysts later this year.

Improvements may result from new ways to use the tools they now have. Once preoccupied with catalyst loss and life, some companies switched to finding out what happened at high-catalyst withdrawals and high-severity operations. They found in some cases increased product yield and quality more than made up for the catalyst loss. The possible introduction this year of a new catalyst said to compare favorably with current ones, at a substantially reduced price will further promote this concept of stressing the positive (performance) rather than the negative (catalyst savings).

Catalytic reforming . . . The big story today is in catalytic reforming. Last year the industry embraced this new processing tool as a "must" to meet new octane levels. Capacity more than doubled and a further increase of more than 60 per cent in new facilities is slated for first operation this year.

The end of 1955 will see cat reforming established in nearly all refineries of importance as the industry completes its first round of construction. Another phase is about to begin. This involves a second round of cat reformer building. The over-all average of 10.5 per cent on crude represents near saturation on the prime heavy naphtha stocks which show the greatest octane improvement by this method.

The second round of new cat reformer capacity will be sparked by two general trends. More light fractions will be fed to cat reformers, and single-

United States Refining Capacity

	Jan. 1, 1953	Jan. 1, 1954	Jan. 1, 1955	Estimated Jan. 1, 1956*
Crude	7,485,280	8,437,314	8,639,255	8,800,000
Per cent annual increase	3.4	12.7	2.4	1.9
Cat cracking	2,417,850	2,829,852	3,280,850	3,470,000
Per cent crude	32.3	33.6	38.0	39.4
Cat Reforming	136,433	249,092	569,330	924,000
Per cent crude	1.8	3.0	6.6	10.5
Polymerization	99,346	104,294	134,819	143,000
Per cent crude	1.3	1.2	1.6	1.6
Alkylation			237,428	244,000
Per cent crude			2.6	2.8

*Does not include estimate of refining capacity which may be shut down during 1955.

Cat Reforming Capacity

(Barrels per stream day)

	Jan. 1, 1954	Jan. 1, 1955	Jan. 1, 1956
Platforming	107,192	277,690	472,540
Hydroforming, F. B.	71,100	67,300	43,300
Hydroforming, fluid	2,000	61,450	61,450
Catforming	20,010	42,550	43,050
Houdriforming	23,540	28,540	56,240
Ultraforming		24,750	92,750
Cycloversion	25,250	19,050	19,050
Sinclair-Baker		19,000	36,000
Thermofor C. R.		19,000	38,500
Sovaforming		9,000	47,000
Hyperforming		1,000	1,000
Undecided			13,120
Total	249,092	569,330	924,000

The figures in these tables are based on The Oil and Gas Journal's Annual Refinery Survey which begins on page 208. With few exceptions, which include new units nearly on stream by the first of this year, the capacity represents the status of the industry as of January 1, 1955.

The total capacity shown for polymerization and alkylation in the tables on this page do not correspond to those in the basic survey because they include a few units which individual companies did not report plant-by-plant.

The estimates of capacity on January 1, 1956, were obtained by adding the new capacity listed in the supplemental survey on new construction. Only those units slated for completion this year were included. The projected estimates do not take into consideration the possibility that some existing refineries may be shut down this year.

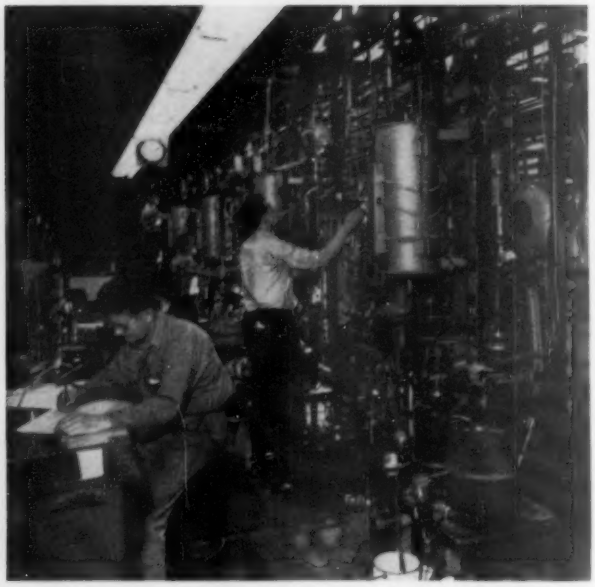
In the table on page 118, the big company category does not include Sunray Mid-Continent for January 1, 1955, since the merger was not effective on that date. The new major appears in the proper category in the estimate for January 1, 1956.

Cat Cracking Capacity

(Barrels per stream day)

	Jan. 1, 1954	Jan. 1, 1955	Estimated Jan. 1, 1956
Fluid	1,940,702	2,362,830	2,461,000
T. C. C.	602,919	652,700	665,000
Houdry	163,390	128,550	128,500
Houdriflow	105,000	123,020	201,800
Cycloversion	17,850	13,750	13,700
Total	2,829,852	3,280,850	3,470,000

WORLD'S SECOND Thermofor cat reformer went on stream last week at Magnolia Petroleum Co.'s Beaumont, Tex., refinery. John W. Newton, vice president and manager of refining for Magnolia, and Goeffrey Purdon, unit operator, are shown checking initial production procedures in front of the new 19,000-bbl. unit.



RESEARCH on catalysts and catalytic conversion processes has reached an all-time high to meet needs of higher octane motor fuels and realize maximum yields of quality products from crude. Part of this effort is this battery of four pilot units at the Socony-Vacuum Research and Development Laboratories, Paulsboro, N. J.

pass reforming will gradually evolve into a recycle type of operation.

First, hydrogen pretreating of reformer feed stocks will add new charging stocks which can be successfully converted in platinum-type reformers. This will include high sulfur and cracked naphthas. Natural gasoline and cycle product should also figure in this expanded feed to cat reformers. Several refiners are now closing long-term contracts for natural gasoline supplies, and are including fairly sizable fractions in their charging schedules for future reforming. This trend will hold if natural gasoline prices remain at present levels. Any sizable cost increase would rule out the use of natural for this type of operation. The new emphasis on removing the heavy catalytic cracked fraction from gasoline blends may add further to admissible cat reforming feed stocks.

The second factor encouraging further cat reforming capacity is the high octane level of current gasoline. By now, 97 research octane premium grade is being marketed on the East and West coasts and in some areas of the Mid-Continent, and 98 octane is present in the Gulf Coast.

Refiners who have maintained the processing pace can match this level in varying quantities and at a price.

But in order to reach 99 or 100-octane levels, the refiner must resort to further processing tools if he is to maintain his position in the growing premium grade market. The answer appears to lie in his ability to raise the octane ceiling of reformate.

One licensor of a catalytic reforming process is already talking about 100 octane clear reformate and two more will have a great deal to say on the same subject next week. It appears that this higher quality will be available through a number of different routes. Higher severity on single pass reforming is one. Extraction of aromatics from reformate and reprocessing of lower-octane paraffin fractions has been under discussion by refiners for some time. Thermal reforming may also return to prominence, in combination with the catalytic process.

These new concepts will boost the future capacity of catalytic reforming to above the 20 to 25 per cent of crude capacity originally considered as ultimate. From all appearances, these new 100-octane units can make use of existing capacity, the net result being more reactor capacity to process the same volume of feed stocks.

Alkylation . . . Despite the fact that refiners cannot justify the economics of blending alkylate to motor fuel, some of this high-octane clean-burning component is going into premium grades. Much of it is being blended as it is available over and above aviation gasoline needs. Obviously, higher-priced avgas still gets the major share of the estimated daily output of about 230,000 bbl.

But alkylate seems slated for increased use in motor fuel, and the key to this development will be lower processing costs. New designs placed in commercial operation during the past 2 years have pointed the way to lower equipment and operating costs. One further development, due shortly, will bring alkylate further into the picture by reducing acid costs. This rather sub-

Capacity: Big vs. Small Refiners

	Companies* controlling more than 100,000 bbl. per stream day in crude capacity			Companies* controlling less than 100,000 bbl. per stream day in crude capacity		
	1-1-54	1-1-55	Est. 1-1-56	1-1-54	1-1-55	Est. 1-1-56†
No. companies	19	19	20	173	157	155
No. refineries	122	119	123	211	183	181
Crude charge capacity	6,769,754	7,044,080	7,213,000	1,667,560	1,595,175	1,587,000
Cat. cracking capacity	2,409,145	2,834,830	3,004,000	420,707	446,020	466,000
Per cent crude capacity	35.6	40.2	41.6	25.3	28.0	29.2
Cat. reforming capacity	151,642	427,530	764,000	97,450	141,800	160,000
Per cent crude	2.2	6.1	10.6	5.8	8.9	10.1
Poly capacity	.....	100,234	107,000	.....	34,585	36,000
Per cent crude	.....	1.4	1.5	.....	2.2	2.3
Alky. capacity	.....	218,334	226,000	.....	19,094	18,000
Per cent crude	.....	3.1	3.1	.....	1.2	1.1

*Including all subsidiaries. †No adjustment made for possible plant shutdowns.

stantial dollar factor may well tip the scale and admit alkylate in much greater quantities to premium gasoline.

Polymerization . . . United States refiners are continuing to add polymerization capacity right and left. Higher conversion operations are making more olefin feed stocks available. Poly gasoline has lost much of its kick in raising the refiner's pool octane as the latter reaches a higher level. But it still remains an important component and will continue to play a major role in maintaining octane levels.

Hydrogen treating . . . This newcomer is catching on fast. Practically all of the current 116,700-bbl. per day capacity was built last year. Capacity will probably double this year. Using by-product hydrogen from cat reformers, this technique blankets the processing scheme, upgrading everything from naphtha to waxes. Its primary use is for catalytic desulfurization of cat reforming feed, burning oil, and diesel fuel. It also improves stability and color of fuels, lubes, solvents, and waxes, and upgrades the catalytic cracking characteristics of cycle stocks.

It is probable that hydrogen treating, the mild form of hydrogenation, will spread throughout the domestic refining scene. Its ultimate capacity could conservatively reach 30 per cent of total crude capacity. Many refiners who have been considering external end uses, like ammonia, for their reformer hydrogen are now veering away from that line of thought. Their research departments tell them that this hydrogen will be greatly needed internally in future processing. Some believe that they may need to make more hydrogen to meet their future refining needs.

All this points to a new dimension in processing which may in time replace most of the conventional treating processes now in use. The last frontier in hydrogen treating—the desulfurization of residual fractions—is now believed to be reached. Successful treating of these heavy stocks on a commercial basis is a possibility to be announced this year by at least two research laboratories.

Thermal conversion . . . The revived interest in coking low-valued residual fractions is the only factor which prevents a more rapid decline in thermal conversion capacity. The first fluid coker went on stream early this year and its successful operation is expected to herald a number of new contracts for such units. Delayed cokers are still being built, too. But gas-oil cracking, visbreaking, and other such processes are rapidly on the way out. Thermal gasoline, once the octane leader, is now an ugly duckling and refiners are scrapping units throughout the country. Thermal reforming may enter the picture in conjunction with catalytic reforming for high-level octane production, but its use alone is rapidly declining in favor of the catalytic process.

Big vs. little refiners . . . There is no discounting the fact that 1955 is going to be a tough year for refining economics. Some refiners who are not maintaining the pace on new processes will probable pass from the picture. Other refiners who operate modern plants will find the going rough, particularly if they do not produce a sizable fraction of their crude requirements.

There is a fallacy, however, in generalizing on the fate of the smaller refiner as a group. From the standpoint of processing capacity, the company controlling less than 100,000 bbl. per day is by no means behind the parade.

The table on page 118 compares catalytic capacities of the majors and the smaller refiners. Even this comparison is unfair to most of the progressive small refiners, as their group includes many small topping plants with no catalytic processing whatever. While they lag the majors on catalytic cracking, these smaller refiners made substantial progress last year and are continuing to add to capacity. They still lead on percentage of catalytic reforming and polymerization capacity, based on crude capacity. Cat reforming programs on the part of the large companies will bring them, as a group, abreast of the smaller refiner late this year.

The United States refiner both large and small will continue to spend money on new equipment. Over-all expenditures this year will not break any records, as most of the attention is directed to product quality rather than outright capacity expansion. The industry is rapidly applying catalysis to every refining process and new developments to be revealed this year will step up the progress of the catalytic era in petroleum conversion.

Canadian Refiners Still Growing

THE refining industry in Canada is still maintaining a fast expansion pace, sparked by new domestic oil production and an exceptional growth in the national economy. Refiners are adding an average of 10 per cent to crude capacity every year and keeping well abreast of modern processing techniques, too.

Having increased crude capacity by 170 per cent during the past 10 years, they have built up an efficient, well-balanced processing industry second to none. In addition to the record construction program, Canadian refiners have replaced older facilities as they went along.

This year the emphasis is on catalytic reforming. From less than 1 per cent of crude capacity, the national average will jump to about 7 per cent by the end of this year. Catalytic cracking has also been added to give the industry the needed facilities for meeting its product distribution.

A number of important building projects are under way. This year Canadian Petrofina, Ltd., will begin operating its 20,000-bbl. per day plant near Montreal. This will rate as the most modern of its type in the world, using five catalytic processes.

Imperial Oil, Ltd., is building a modern lube plant at Edmonton which will use Hydrofining, a catalytic hydrogen treating process to produce high-quality product. The company is expanding at Montreal East and is adding polymerization facilities at the West Coast plant near Vancouver. Also under way is a major revamping of the Imperoyal refinery near Halifax. Practically all the older units will be replaced and the plant will emerge with almost double its former capacity. This project is not due for completion until next year. It is not included in the estimated capacity totals for January 1, 1956, in the accompanying table.

British American Oil Co., Ltd., is

CANADIAN REFINING CAPACITY
(Barrels per stream day)

	Jan. 1, 1953	Jan. 1, 1954	Jan. 1, 1955	Estimated Jan. 1, 1956
Crude	505,935	570,560	608,740	666,940
Per cent annual increase	15.8	12.8	6.8	9.5
Thermal cracking	150,510	170,804	172,134	175,934
Per cent of crude	29.7	29.9	28.3	26.4
Catalytic cracking	95,110	168,108	211,550	249,650
Per cent of crude	18.8	29.4	34.7	36.4
Catalytic reforming	4,000	8,930	12,030	45,630
Per cent of crude	0.8	1.6	2.0	6.8
Polymerization	10,565	11,894	19,424	22,430
Per cent of crude	2.1	2.1	3.2	3.4

adding two Catformers, a 2,000-bbl. unit at the Calgary refinery and a 13,000-bbl. unit at Montreal East. Also at Montreal, McColl-Frontenac Oil Co., Ltd., is building a 12,000-bbl. Platformer.

The spending for new plant facilities is by no means restricted to the larger companies. As in the U.S., it is the smaller refiners who have led the way with catalytic reforming units. Led by Canadian Oil Refineries, Ltd., and Trinidad Leaseholds, which added new Platformers, a number of other refiners are now under way with similar building projects.

Anglo-American Exploration, Ltd., is planning a 1,000-bbl. Catformer at Hartell, Alta. Two plants, at Fort Williams, Ontario, and Moose Jaw, Sask., which were recently acquired by Husky Oil & Refining, Ltd., are being built with new crude capacity, catalytic reformers and Diesulforming units. The latter are catalytic hydrogen treating units using a process developed by the U.S. affiliate, Husky Oil Co. Another complete rebuilding program is under way by North Star Oil, Ltd., at Boniface, Man. The new refinery will boast modern two-stage crude distillation, Orthoflow catalytic cracking and polymerization.

INDUSTRY AFFAIRS

Gas Battle Shapes Up

"Economic waste" bill before Texas Legislature is pushed by independents, fought by pipelines and large producers

Robert J. Enright

AUSTIN.—A battle royal is shaping up within the industry over the so-called "economic waste" gas bill now being studied by Texas legislative committees.

No matter who wins, the outcome of this fight is expected to have a weighty effect on whether the federal Government, the state, or neither controls gas prices.

The Texas bill would give the Texas Railroad Commission the power to hold hearings to fix the value of gas from any well or field in the state at a level to prevent "economic waste." It is believed this level would be somewhere between 7 and 10 cents an M.c.f.

If a gas purchaser should fail to pay this minimum, the commission could shut in production from the field until the price were met.

Pushing the bill hard is an active group of independents in Texas, led by the Texas Independent Producers and Royalty Owners Association.

Opposing it are the pipelines and larger producers.

The Railroad Commission itself has not sought such legislation. Commissioners E. O. Thompson and W. J. Murray took about the same stand last week at a hearing on the bill before the house oil, gas, and mining committee.

Thompson said "there are some inequities" (in gas pricing in Texas), but he feels the commission doesn't need the bill and definitely isn't asking for it.

Murray said the commission is taking no stand for or against the bill. He said he thinks the law of supply and demand should work to the best interests of everyone, adding that he has had his "attention called to inequities that do exist today."

Neither side is sure of victory. Jack

TIPRO's JACK WOODWARD ... can't haul gas like wheat

Woodward, president of TIPRO, said last week that the independents are bucking "powerful opposition." An official with one of the larger Texas gas producers said he couldn't predict whether the bill would pass. A legislator in one of the producing districts, the official said, had declared that he felt he had to vote for the bill due to heavy pressure exerted on him by the large number of producers in his district.

What it is . . . The "economic waste" bill is, in effect, a minimum-price bill. Similar bills have been before the Texas Legislature before but haven't gotten very far. This year its backers are attacking from a different direction. They argue the proposed law would knock the props from under the gas-price freeze imposed by the Federal Power Commission . . . nullify any federal regulatory power over prices charged by gas producers.

The reasoning goes this way: The United States Supreme Court affirmed the validity of a state-set minimum price when the Kansas case came before it. If it's legal in Kansas and Oklahoma, it's legal in Texas. Under the law, the Railroad Commission could shut in a field or any number of fields where prices were determined to be too low. Gas supplies to interstate pipelines could be reduced drastically. Since FPC must protect gas consumers, it would be forced to unfreeze field prices.

At the same time, the bill would end a long period of exploitation of small gas producers by the pipelines, the independents say. They point to Hugoton field in the Panhandle where roughly 20 per cent of field production is under life-time contract at 3 cents per M.c.f., as compared to some recent contracts calling for 12 or more cents an M.c.f. and escalation provisions.

They contend that the Hugoton case is not an isolated one and that price inequities are widespread over the state. A small producer, TIPRO's Woodward says, can get a realistic price for a new source of gas supply if there are two or more pipelines in the area competing for the gas. It's a different story if there is only one line, he said.

"Suppose you (a small producer) discover and develop a small gas field in such an area," Woodward said. "You complete seven or eight wells in the field which is perhaps 20 or 30 miles from the nearest and only existing pipeline. You go to this pipeline, asking for the going price in the area of about 10 cents. You stand little chance of getting it.

"The pipeline won't offer you the lowest price . . . But probably about 6 cents. What can you do? You can't load trucks with gas like wheat and haul it somewhere else to talk to another prospective buyer."

The independents say the bill is not a radical or revolutionary measure. TIPRO argues that it would only "give

the Railroad Commission the power to regulate production of gas on the same basis as it does oil . . . to take appropriate action, field by field, after the customary notice and hearing, to assure that smaller producers and royalty owners are not allowed to cause waste."

An argument in favor of the bill which may prove tempting to revenue-seeking Texas legislators is that higher wellhead prices for Texas gas would increase state gas-tax revenues substantially.

On the other side . . . The bill will not have easy sledding through the legislature.

Pipelines and larger gas producers are working hard to prove that passage of any such law would be a mistake.

The pipelines say the bill is an adroit effort to permit its backers to break present contracts with pipeline companies including transmission and distribution firms supplying the Texas public and industry.

This is being done under the guise of conservation, they say, when actually there is no substantial waste of gas in Texas and no such thing as economic waste.

TIPRO, pipeline representatives say, is in the untenable position of trying to persuade Congress that there should be a free competitive market for selling gas at the wellhead, while in Texas it wants legislation to provide a high minimum price. In Washington, the independents are stoutly defending the sanctity of contracts, while in Texas they want to break them.

A high minimum gas price in Texas would deal a heavy blow to consumers both in and out of the state since the pipelines are regulated and have to pass on price hikes to the gas user. This would more than counteract any gain in state revenues, the pipelines say.

Large producers' stand . . . Larger gas producers are fighting the economic-waste bill for three primary reasons:

The first, a traditional one, is that they are opposed to price-fixing of any kind either maximum or minimum by regulatory bodies.

Secondly, they fear that the proposed bill and the ruckus which has accompanied it will do considerable harm to industry efforts in Washington to get out from under FPC price-fixing powers. Congressmen from consuming states are given a golden opportunity to argue that the producers are two-faced and that federal control must be retained to protect the consumer from sky-rocketing gas rates. Passage of the Texas bill would damage this cause even further, they say.

The larger producers also fear that stretching the present meaning of waste in the Texas conservation statutes to include "economic waste" might do severe damage to the entire state oil and gas conservation setup.

Any attempt to use the law, if and when passed, as a lever to force the FPC to unfreeze gas prices probably would flop hard, they say. This is why:

When Kansas' minimum wellhead gas price law was carried to the Supreme Court and ruled valid, Justice Tom Clark said in effect that the state was being allowed to regulate the price of gas going interstate only because there was no federal law which adequately covered the subject. Thus, he said that a state could legally regulate interstate commerce in some instances where there were no federal regulations.

It was implied, however, that if there were a federal law, the state would have to give way.

The federal Government was given a law under which to regulate the price of gas going interstate under last year's Supreme Court interpretation of the Natural Gas Act in the Phillips case.

Any test of a state minimum-price law now, the large producers think, quite probably would see a different outcome.

An executive of one large producing company pointed out that his company felt strongly enough about the issue to disregard financial gain.

"We made money in Kansas and Oklahoma when those states passed minimum wellhead prices for gas. But we fought passage of the bills in those states and we will fight it in Texas. We believe price-fixing by any regulatory body is bad in the end for both the industry and the gas consumer."

C.I.O. Approves Wage Offers

DENVER.—The Oil, Chemical and Atomic Workers International Union (C.I.O.) last week authorized locals to sign new contracts providing general wage increases averaging about 10 cents an hour for employes in the oil industry.

But President O. A. (Jack) Knight, in flashing the green light for new agreements, warned there may be additional wage demands this year.

"It is the attitude of the union that what we are actually getting is a wage increase in 1955 which was due to oil workers in 1954," Knight said. "Therefore, there is a strong possibility that within a few months we may launch a new campaign for 1955 wage increases."

The 10 cents represents an increase of about 4 per cent, the same as the oil workers' last general boost in mid-1953. They had asked 5 per cent, or 11½ to 12 cents an hour, in a campaign launched last June 4 by the old Oil Workers International Union.

Knight credited the wage increase to the 9-month campaign of O.W.I.U., which merged with United Gas, Coke and Chemical Workers of America (C.I.O.) March 4 in Cleveland. The new oil-chemical-atomic workers union emerged with Knight as its $12,000-a-year president *(The Oil and Gas Journal, March 14, page 84)*.

First offers were made by a few major companies during the unions' merger meeting. Other firms joined the parade with proposed increases of either 4 per cent or 10 cents an hour.

Extent of raise . . . Clearance from O.C.A.W. headquarters broke the indecision which had kept many locals from immediately accepting the wage offers. After Knight's announcement, most locals in the old O.W.I.U. either accepted or prepared to vote on the offer.

Knight said the average increase actually is "somewhat higher than 10 cents" an hour.

Knight claims it is the largest wage hike won by any union in a major industry in more than a year. The new base pay will average about $2.40 an hour for workers in oil refining, production, and pipeline transportation, the union estimates.

The union president said the pay increase will amount to more than $100,000,000 a year. He estimated approximately 500,000 oil workers will benefit from the raise.

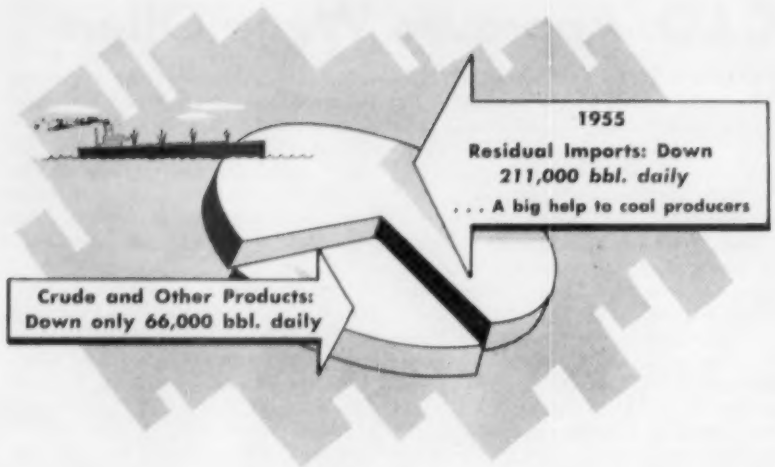
Pipeline Protest Renewed

PHILADELPHIA.—Panhandle Eastern Pipe Line Co. asked the Third Circuit Court of Appeals to take another look at the Detroit gas situation.

The company asked the court to reconsider its February 25 decision refusing a review of the conditional certificate granted American - Louisiana Pipe Line Co. by the Federal Power Commission. Panhandle says the court had not looked at all the facts.

Panhandle has been fighting the 1,300-mile American-Louisiana line for months. Panhandle claims American-Louisiana does not have a "lawful" supply of gas and that the line would create a "monopolistic program" in the Detroit area. Producers who will supply gas to American-Louisiana will be heard by the FPC April 18 *(The Oil and Gas Journal, March 14, page 85)*.

If the project is approved, Panhandle faces the threat of losing its Detroit market.


1955
Residual Imports: Down
211,000 bbl. daily
. . . A big help to coal producers
Crude and Other Products:
Down only 66,000 bbl. daily

Coal, not oil, will win . . .

. . . If the Neely Bill Passes

- **It would cut imports of residual 211,000 bbl. daily but trim crude and all other products only 66,000 bbl.**
- **This means only a token cut for domestic producers but a shot in the arm for the nation's coal industry**

John C. Casper

OIL men are likely to be disappointed in practical applications of the Neely amendment.

The proposal to amend the Reciprocal Trade Agreements Act by limiting oil imports to 10 per cent of demand was presented as the answer to slowing the flood of foreign oil.

Mathematics of its formula, however, would favor coal men.

Domestic producers in the first year would win only 66,000 bbl. daily reduction in imports of crude and other products. This is a mere fraction of the relief they contend is needed.

In the second year some of this token relief would be lost under the formula which would allow crude imports to move up 36,000 bbl. daily.

Thus at the end of 2 years the amendment would help the domestic crude producer only 30,000 bbl. daily compared with the 227,000 bbl. daily reduction in the imports of residual fuel —the prime competitor of coal.

It works like this. Imports of all oils would be limited to 10 per cent of the previous year's domestic demand, calculated by quarters. But within this over-all limitation, residual oil also would be allowed a specific reduction to 10 per cent of its own domestic demand.

This means that residual oil would stand three-quarters of the reduction. Crude and all other petroleum products would get only one-quarter.

So what happens? The price of residual probably would move up some because of the shortage of supply but not enough to make it attractive to domestic refiners.

Switch to coal . . . Inland refiners still couldn't pay the high freight costs of moving their products to the eastern residual markets. Coastal refiners of domestic crude likely wouldn't change their yield pattern after installing costly equipment to make more profitable products from fractions which formerly went into residual fuel.

The result would be a quick switch by industrial users of the heavy oil to coal or natural gas. They would do that with only a slight increase in the residual price.

This would tend to reduce further the consumption of residual. Then under the second year's operation of the Neely amendment, the imports of residual would be reduced again by applying the formula to the lowered base demand for the previous year. Again a boost for coal.

Let's take '55 . . . If the amendment were in effect for 1955, total imports for the year would be 277,000 bbl. daily less than in 1954. Residual imports would be cut 211,000 bbl. daily, or 76 per cent of the total, and other products and crude 66,000 bbl. daily for 24 per cent *(see table)*.

When compared with 1954 the amendment would decrease 1955 total of foreign imports 26.33 per cent. Residual imports would be reduced 59.6 per cent. Crude and all other products would be cut by only 9.46 per cent.

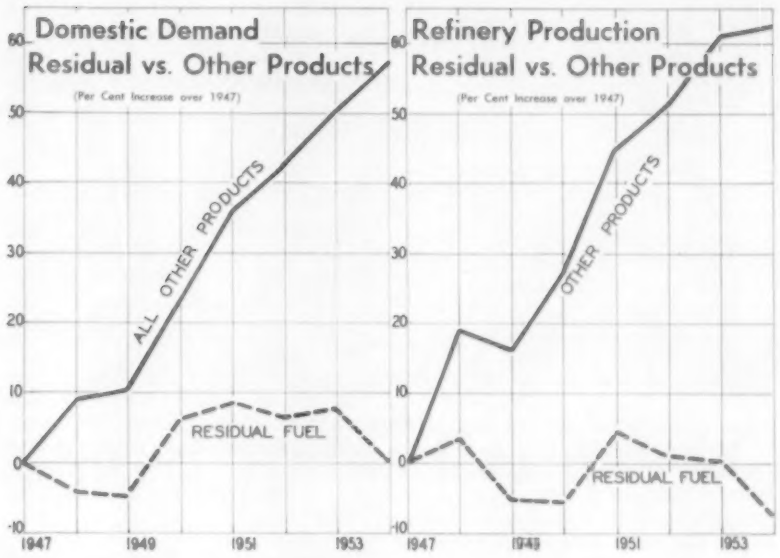
The domestic crude producer and refiner would benefit very little from the decrease in residual imports. Postwar increases in demand for residual

IMPORTS UNDER THE PROPOSED NEELY AMENDMENT*

(Thousands of barrels daily)

	First quarter	Second quarter	Third quarter	Fourth quarter	Year
IMPORT ALLOWABLES IN 1955					
Total imports	826	720	725	830	775
Residual imports	166	131	121	155	143
Other products and crude	660	589	604	675	632
ACTUAL IMPORTS IN 1954					
Total imports	1,101	975	983	1,149	1,052
Residual imports	434	298	254	429	354
Other products and crude	667	677	729	720	698
CHANGES, 1955 VS. 1954					
Total imports	—275	—255	—258	—319	—277
Residual imports	—268	—167	—133	—274	—211
Other products and crude	— 7	— 88	—125	— 45	— 66
CHANGES (PER CENT) 1955 VS. 1954					
Total imports	—24.98	—26.15	—26.25	—27.76	—26.33
Residual imports	—61.75	—56.04	—52.36	—63.87	—59.60
Other products and crude	— 1.05	—13.00	—17.15	— 6.25	— 9.46
DOMESTIC DEMAND IN 1954					
All oils	8,261	7,202	7,245	8,304	7,752
Residual fuel	1,658	1,307	1,211	1,549	1,430

*Total imports limited to 10 per cent of total United States domestic demand. Residual imports held to 10 per cent of domestic demand for residual.



fuel have not kept pace with other oil products. This has been influenced by shifts to diesel fuel by railroads and by competition from natural gas. Another important factor has been the need for refiners to shift yields toward higher-priced products.

Refiners will not rush in to fill the deficient supply of residual created by a reduction in imports. The refiner has geared his plant to produce less residual. No Gulf Coast refiner, for instance, with facilities for processing residual to lighter fuels will be tempted to increase yields of residual fuel selling for 4.64 cents a gallon and cut back production of No. 2 distillate bringing 9 cents or gasoline at 10.5 cents.

Imports fill gap . . . Refinery production of residual for 1954 was 7.0 per cent less than for 1947. Production of all other products increased 56.8 per cent in the same period. This shows the trend against domestic residual output.

Residual imports moved in to pick up the slack. The imports represented 10.5 per cent of domestic demand in 1947 and climbed to 24.7 per cent by 1954. While domestic demand for residual in 1954 was only 0.6 per cent greater than in 1947, refinery production of this product actually was 7.0 per cent less than in 1947. The postwar peak residual output was in 1951 when the average reached 1,546,000 bbl. daily but at that only 8.8 per cent more than in 1947.

The amendment would cut domestic demand for residual fuel and for all oils in 1955. Earlier this year the Journal forecast domestic demand for residual at 1,493,000 bbl. daily and domestic demand for all oils at 8,175,000 bbl. daily. These forecasts included residual fuel imports of 380,000 bbl. daily.

All oils down . . . Under the amendment, residual imports would be limited to 143,000 bbl. daily or a reduction of 237,000 bbl. daily. Considering the trend toward lower refinery yields of residual fuel, only a very small part of this cut would be offset by increased refinery production.

Allowing for this small shift in refinery yield, it is estimated that domestic demand for residual would be reduced by 220,000 bbl. daily compared with the cut of 237,000 bbl. daily from expected imports. Under the amendment, domestic demand for residual in 1955 would be forecast at 1,273,000 bbl. daily.

A reduction in residual demand would mean an equal reduction in domestic demand for all oils. The cut of 220,000 bbl. daily would bring the forecast for total domestic demand down to 7,955,000 bbl. daily. These new domestic demand averages, 1,273,000 bbl. daily for residual and 7,955,000 bbl. daily for all oils, would be the bases for calculating 1956 imports under the proposed amendment.

Coal benefits . . . Total imports for 1956 would be limited to 10 per cent of total domestic demand in 1955 or 795,000 bbl. daily. Residual imports would be 10 per cent of domestic demand for residual or 127,000 bbl. daily. The following is a comparison of these 1956 imports with imports for 1955 under the amendment, in thousands of barrels daily:

	1956	1955	Increase
Total imports	795	775	20
Residual imports	127	143	—16
Crude and other prod.	668	632	36

Not only would the coal producers get the lion's share of the import reduction in 1955 but also would gain through a further reduction in residual imports in 1956.

Oil men have their say as . . .

. . . Committee Studies Neely Bill

WASHINGTON.—Two big importers last week agreed to hold the line on imports. But one warned his company will play the game so long as no one steps out of bounds.

In a hearing before the Senate finance committee, Eugene Holman of Standard Oil Co. (N. J.) and Sidney A. Swensrud of Gulf Oil Corp. endorsed the cabinet fuels committee's recommendation that imports be held at the 1954 ratio of domestic production. But the Gulf chairman said his company would follow the recommendation only "so long as other importers do likewise."

While the importers were pledging to hold the line, independent refiners were charging that the fuels recommendation will still permit excessive imports, and producers were declaring they have no faith in voluntary controls.

The importers . . . Holman told the committee that Jersey Standard cut its crude imports in 1953 and again in 1954. Its residual imports were 3 per cent higher last year, he said. But they were no greater than in 1952 and less than in the previous 2 years.

Holman warned against any import formula that would freeze the situation. Supply and demand are never static, he said.

Residual fuel should get special treatment, he said. New techniques are cutting into the heavy oil at the bottom of the barrel. Even if residual demand does not increase over last year, higher imports will be necessary to supply existing customers.

So far as crude oil is concerned, there is no need for the Neely amendment limiting imports to 10 per cent of domestic demand, Swensrud asserted. Last year, he said, new records were set in wells drilled and money spent in exploration. Production now is at a higher level than ever before.

Except for early in 1920, the price of crude is higher than ever.

"This record does not indicate that our domestic industry is withering on the vine," Swensrud said.

The refiners . . . M. H. Robineau, president of the Independent Refiners Association of America, said Congress should provide a yardstick to measure imports. Machinery should be set up for the continuous review which the committee recommended. And the companies should have government help in cutting imports and protection against antitrust charges for whatever joint action that might result.

Robineau suggested that cutbacks be directed more to oil from the Middle East than to the Western Hemisphere.

The producers . . . Several spokesmen appeared for independent producers to protest the recommendations. Several said the Neely amendment was the only way to do the job.

William M. Vaughey, president of the Independent Petroleum Association of America, said Congress is the last resort of the domestic producers. Voluntary restrictions are not practical for political, economic, and competitive reasons, he said.

Sunray-D-X Merger Nears

TULSA.—Final step in merger of Sunray Oil Corp. and Mid-Continent Petroleum Corp. is scheduled May 10 when stockholders of the two companies will vote on the plan.

Details of the merger agreement have been worked out by Sunray and Mid-Continent directors. The directors have approved the merger in principle *(The Oil and Gas Journal, January 31, page 117).*

Directors of the merged firm, to be known as Sunray Mid-Continent Oil Co., will include nine men now on the Sunray board and six on the Mid-Continent board. They are: J. K. Ellis, D. L. Frawley, Edward Howell, F. B. Parriott, A. A. Seeligson, Glenn J. Smith, Paul E. Taliaferro, W. C. Whaley, and C. H. Wright, all of Sunray, and J. Luther Cleveland, Jacob France, Robert W. McDowell, William F. Morton, E. M. Rouzer, and Jay P. Walker of Mid-Continent.

Wright, Sunray chairman, is to be chairman and chief executive officer of the new company. Whaley, Sunray president, will be president of Sunray Mid-Continent. McDowell, who is now president of Mid-Continent, will be president of D-X Sunray Oil Co., subsidiary which will handle crude pipeline, refining, and marketing activities. McDowell also is to be vice chairman of the parent company.

Merger Proposed

South Penn and Pennzoil directors approve plan

BRADFORD, Pa.—Merger of Pennzoil Co. into South Penn Oil Co. has been approved by directors of the two companies.

The plan will be presented to Pennzoil shareholders June 15. South Penn stockholders will act on the proposal the following day.

South Penn, with headquarters at Bradford, has oil production in Pennsylvania, West Virginia, and New York. It owns a majority of the stock in Pennzoil Co., which operates a 10,000-bbl. refinery near Oil City, Pa.

Pennzoil is primarily engaged in the refining, sale, and distribution of products refined from Pennsylvania Grade crude, and South Penn is its principal source of raw material. Under the merger plan Pennzoil would operate as a division of the surviving company. Brand names of its products, Pennzoil motor oil and Pennzip gasoline, would be unchanged.

The merger agreement provides for all directors of the two companies to be members of the board of the surviving firm. Charles L. Suhr, Pennzoil chairman, would be chairman of the board of South Penn Oil Co. George J. Hanks, now chairman of South Penn, would become president. Other top officers would be R. W. Grunert, senior vice president, South Penn division, and W. S. Zehrung, senior vice president, Pennzoil division.

Humble Plans Arizona Tests

LOS ANGELES.—Humble Oil & Refining Co. will invade a new exploratory region this year when it drills two wildcats in the northeastern Arizona portion of the Four Corners area.

The tests, northwest of Shell Oil Co.'s recent gas discovery in Apache County, Arizona, will be Humble's first attempts in the region. Shell completed its 2 East Boundary Butte discovery last October at the plugged-back depth of 4,884 ft. The well flowed 2,500,000 cu. ft. of gas per day through ⅜-in. choke.

Shell is now completing its North Boundary Butte discovery in San Juan County, Utah. The well recovered oil at the rate of 913 bbl. per day on a drill-stem test in the Pennsylvanian-Paradox at 4,713-49 ft. *(The Oil and Gas Journal, February 28, page 81.)*

Shell, most active operator in the region, has reached a depth of 4,380 ft. at the 26-36 Desert Creek, confirmation to the 1954 Desert Creek discovery 5 miles northeast. The Desert Creek oil discovery was one of the exploration highlights of 1954 in the Rocky Mountains. It opened a new basin to commercial oil production and provided the first production from the Paradox formation.

Deep Wildcat Is Dry Hole

PARKERSBURG, W. Va.—The deepest well ever drilled in the Appalachian area is a dry hole. It is Hope Natural Gas Co. 9634 Power Oil Co., in the Walker district of Wood County, West Virginia.

Falcon Seaboard Drilling Co. of Tulsa moved a heavy rotary rig from western Oklahoma last year for the job and completed the rank wildcat at total depth of 13,331 ft. Last top reported was the Beekmantown at 10,494 ft.

"Detroit Case" Back in Court

CHICAGO.—A 15-year-old price-discrimination suit against Standard Oil Co. (Ind.) was back in court last week.

The company asked the United States Court of Appeals here to dismiss the case, commonly known as the "Detroit case."

The case has been in and out of court since 1940 when the Federal Trade Commission charged Standard with price discrimination under the Robinson-Patman amendment to the Clayton Act. The suit involved sales by the company in the 1930s to four jobbers in Detroit at lower prices than retail dealers were charged.

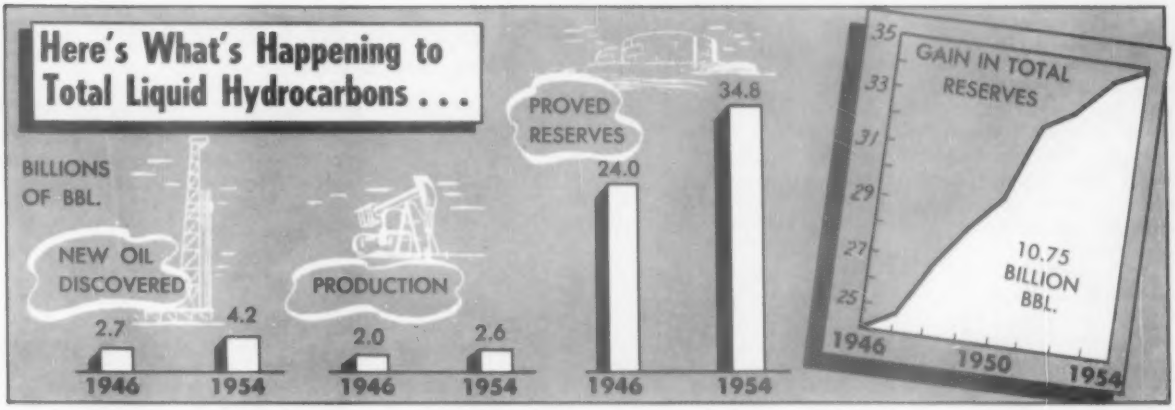
Standard contended it was simply meeting prices offered by its competitors. The United States Supreme Court in 1951 upheld the company's right to meet competition.

Demand for Gas Growing

NEW YORK.—By the beginning of the 1956-57 heating season, approximately 60 per cent of the heating customers in the United States will be using natural gas. This will be about a 9 per cent increase over the present number.

The American Gas Association estimates 2½ million homes will install gas-heating equipment during the next 2 years. This will up the number of homes served by natural gas to 16½ million. There are about 14 million currently served by natural gas.

The biggest increase during the 2 years will be made in the east north central states. Approximately 350,000 homes will install natural-gas heating equipment in this area. The association estimates 342,000 new customers will be added in the middle Atlantic area.



United States Reserves Climb Again

But, it's the smallest total gain ever reported by the A.P.I.-A.G.A. group; "extensions, revisions" minimized

NEW YORK.—Proved reserves of total liquid hydrocarbons in the United States rose to a new high in 1954, but the net increase was the lowest since total liquid hydrocarbon figures were first compiled in 1947.

The American Petroleum Institute and the American Gas Association estimate total liquid hydrocarbon reserves at the end of 1954 were 34,805,203,000 bbl., a net increase during the year of only 422,453,000 bbl.

The Oil and Gas Journal estimate of total reserves at the end of the year was 36,050,000,000 bbl. with a net increase during 1954 of 1,414,000,000 (January 31, page 148).

According to the A.P.I.-A.G.A. committees, production of total liquid hydrocarbons in 1954 dropped 2.2 per cent from the previous year. Crude production accounted for almost all the drop with natural gas liquids credited with only a small portion of the decline.

If the committee's estimated increase in net reserves, 422,453,000 bbl. is added to production of 2,557,934,000 bbl., a new supply of 2,980,387,000 bbl. is indicated for 1954. This is more than 1,000,000,000 bbl. less than the new supply the committees estimated for 1953.

The new supply figures are estimated from new fields and new pools in old fields, plus revisions and extensions for discoveries in past years. This year the committees made rather drastic downward revisions in their figures on revision and extension of natural gas and natural gas liquid reserves for a number of states.

How estimates are made . . . The committee each year calls attention to the fact that totals assigned to pools discovered during the year are only a part of the production expected from these fields.

Discoveries, both in new fields and in new pools of old fields, are seldom fully developed the first year or for several years. So the committee estimates of reserves from these fields are only a portion of the reserves which may finally be assigned to new reservoirs discovered each year.

The committees revise estimates of reserves in older fields as factors affecting production and reservoir performance becomes better known.

It is fairly obvious from the figures in the 1954 estimates that the committees have come to the conclusion their revision and extension estimates

Proved Reserves of Liquid Hydrocarbons

(Thousands of barrels)

	Proved reserves as of 1-1-1954	Extensions and revisions	New discoveries	Prod. during 1954	Proved reserves as of 1-1-1955	Changes in reserves during 1954
Alabama†	17,160	—17		1,578	15,565	—1,595
Arkansas	407,816	17,004	1,989	28,470	398,339	—9,477
California*	4,244,245	332,577	28,695	386,680	4,218,837	—25,408
Colorado	329,943	30,272	27,785	46,602	341,398	11,455
Illinois	641,846	104,626	3,607	69,448	680,631	38,785
Indiana	62,273	15,128	1,181	11,248	67,334	5,061
Kansas	1,091,069	155,448	30,630	123,501	1,153,646	62,577
Kentucky	89,431	19,117	3,269	15,736	96,081	6,650
Louisiana*	3,572,869	363,075	171,761	262,008	3,845,697	272,828
Michigan	61,362	9,872	1,321	12,022	60,533	—829
Mississippi	404,835	95,772	7,470	35,381	472,696	67,861
Montana	211,893	80,408	1,604	14,332	279,573	67,680
Nebraska	28,655	10,107	9,698	8,161	40,299	11,644
New Mexico	1,135,559	84,551	11,707	85,940	1,145,877	10,318
New York†	49,083			3,252	45,831	—3,252
North Dakota†	128,271	10,384	1,814	6,120	134,349	6,078
Ohio	33,185	8,923	9	3,906	38,211	5,026
Oklahoma	2,056,460	405,177	39,560	211,938	2,289,259	232,799
Pennsylvania	113,851	156	78	9,367	104,718	—9,133
Texas*	18,265,862	459,787	304,859	1,120,368	17,910,140	—355,722
Utah	37,990	225	166	1,920	36,461	—1,529
West Virginia	64,825	13,335	1,112	7,966	71,306	6,481
Wyoming	1,329,669	92,122	23,591	91,119	1,354,263	24,594
Miscellaneous‡	4,598	12	420	871	4,159	—439
Total U. S.	34,382,750	2,308,061	672,326	2,557,934	34,805,203	422,453

Only a limited area is assigned to each new discovery. The concern is only with actually proved reserves.

*Includes off-shore reserves. †Crude oil only. ‡Includes Alabama and North Dakota natural gas liquids; Missouri, Nevada, South Dakota, Tennessee and Virginia crude; and Florida crude and natural gas liquids.

in 1953 or for years before that were out of line.

The net noticeable downward revision in the estimates appears in natural gas liquids where a net decrease of 193,465,000 bbl. over 1953 reserves is shown. Extensions and revisions for Texas alone accounted for a decrease of more than 220,000,000 bbl. This is 6 per cent of Texas natural gas liquid reserves.

Crude oil . . . Production of crude during 1954 dropped 2.4 per cent from the committees' 1953 production figure but crude reserves increased 2.1 per cent. The net increase estimate for crude reserves is 368,356,000 bbl. below the net increase estimate for 1953.

The committee report on crude reserves gives a breakdown of additions to reserves during the year. Of the 2,873,037,000 bbl. of crude reserves added in 1954, oil discovered in new fields or in new pools in old fields accounted for only 585,806,000 bbl. and extensions of old fields and revisions in estimates furnished the remainder.

Two states, Oklahoma and Louisiana, contributed 65.8 per cent of the net increase in crude reserves for the entire country in 1954.

Natural gas liquids . . . Proved reserves of natural-gas liquids the first of 1955 were estimated by the A.P.I.-A.G.A. committees at 5,244,457,000 bbl. This is a decrease of 193,465,000 bbl. from the estimate at the beginning of 1954.

New discoveries accounted for 86,520,000 bbl. of additions in this category and extensions and revisions only 20,830,000 bbl. on the credit side of the ledger. Production of 300,815,000 bbl. during 1954 more than wiped out these additions.

It was in the new fields and pools and extensions and revisions of natuaral-gas liquid reserves that the committees made their major changes. Only California, Colorado, Kentucky, Illinois, Louisiana, Michigan, Mississippi, Nebraska, New Mexico, West Virginia, and Wyoming were boosted in reserve figures in the new field and new pool category. Only Louisiana and New Mexico had sizable increases.

The biggest change came in extensions and revisions. Sizable reductions were made in these reserves in Nebraska, Arkansas, Texas, and Utah. In Texas alone, the committees sliced 220,506,000 bbl. from reserves by revisions.

Natural gas . . . New records were set in 1954 for natural-gas production and estimates of gas reserves hit a new all-time high of 211,710,732,000 M.c.f. The net increase in gas reserves estimated by the committee, however, was the smallest ever reported. It was so

Proved Reserves of Crude Oil

(Thousands of barrels)

	Proved reserves as of 1-1-1954	Extensions and revisions	New discoveries	Prod. during 1954	Proved reserves as of 1-1-1955	Changes in reserves during 1954
Alabama	17,160	—17		1,578	15,565	—1,595
Arkansas	358,231	17,802	1,944	26,557	351,420	—6,811
California*	3,919,379	298,729	26,345	355,865	3,888,588	—30,791
Colorado	319,254	27,554	27,772	45,929	328,651	9,397
Illinois	624,803	96,162	3,202	65,756	658,411	33,608
Indiana	62,128	15,091	1,179	11,215	67,183	5,055
Kansas	913,341	155,163	28,182	118,237	978,449	65,108
Kentucky	81,655	13,813	3,117	13,244	85,341	3,686
Louisiana*	2,759,655	276,150	152,541	226,695	2,961,651	201,996
Michigan	60,721	9,601	1,242	11,944	59,620	—1,101
Mississippi	350,101	88,302	6,528	32,655	412,276	62,175
Montana	208,985	75,837	1,604	14,032	272,394	63,409
Nebraska	25,621	10,833	9,615	8,038	38,031	12,410
New Mexico	814,902	55,647	8,131	72,794	805,886	—9,016
New York	49,083			3,252	45,831	—3,252
North Dakota	128,271	10,384	1,814	6,120	134,349	6,078
Ohio	31,826	8,833		3,887	36,772	4,946
Oklahoma	1,752,228	353,802	32,932	183,614	1,955,348	203,120
Pennsylvania	111,083			9,234	101,849	—9,234
Texas*	14,998,620	680,293	254,935	951,845	14,982,003	—16,617
Utah	37,937	227	166	1,916	36,414	—1,523
West Virginia	36,612	2,700	900	2,900	37,312	700
Wyoming	1,279,110	90,313	23,237	89,083	1,303,577	24,467
Miscellaneous†	4,122	12	420	729	3,825	—297
Total U. S.	28,944,828	2,287,231	585,806	2,257,119	29,560,746	615,918

*Includes off-shore reserves. †Under miscellaneous are included Florida, Missouri, Nevada, South Dakota, Tennessee, and Virginia.

Proved Natural-Gas Recoverable Reserves

(Millions of cubic feet—14.65 psia. at 60° F.)

	Reserves as of 1-1-54*	Changes in reserves during 1954				Reserves as of 1-1-55*
		Extensions and revisions*	Discoveries*	Net change in underground storage†	Net production‡	
Arkansas	1,211,266	—19,422	3,872	1,689	32,026	1,165,379
California§	9,159,347	287,939	59,110	—11,255	468,538	9,026,603
Colorado	1,864,275	—49,945	174,374	0	55,791	1,932,913
Illinois	231,251	33,206	4,048	19,802	34,551	253,756
Indiana	35,830	7,258	285	—1,275	6,050	36,049
Kansas	15,787,602	179,140	233,601	10,768	452,779	15,758,332
Kentucky	1,301,533	44,815	10,340	1,919	72,000	1,286,607
Louisiana§	34,458,912	2,595,319	1,252,836	0	1,507,081	36,799,986
Michigan	275,519	37,163	7,961	19,093	9,636	330,100
Mississippi	2,569,181	361,267	8,750	159	166,674	2,772,683
Montana	764,000	—31,127	22,674	1,179	32,995	723,731
Nebraska	182,110	6,742	17,009	0	12,915	192,946
New Mexico	17,522,210	—331,033	549,760	—26,636	473,632	17,240,669
New York	71,004	298	0	1,913	3,853	69,362
Ohio	755,982	27,859	8,780	13,651	31,531	774,741
Oklahoma	12,228,373	771,691	247,151	6,914	857,981	12,396,148
Pennsylvania	751,844	72,034	21,325	45,010	158,050	732,163
Texas§	106,529,626	1,278,190	2,078,659	6,002	4,763,415	105,129,062
Utah	1,113,058	—716,993	7,733	0	16,423	387,375
West Virginia	1,653,942	100,743	22,000	104	169,499	1,607,290
Wyoming	2,739,631	—27,018	229,019	1,868	88,429	2,855,071
Miscellaneous¶	240,636	4,183	7,607	0	12,660	239,766
Total	211,447,132	4,632,309	4,966,894	90,906	9,426,509	211,710,732

*Excludes gas loss due to natural gas liquids recovery. †The net difference between gas stored in and gas withdrawn from underground storage reservoirs, inclusive of adjustments and native gas transferred from other reserve categories. ‡Net production equals gross withdrawals less gas injected into producing reservoirs. Changes in underground storage and gas loss due to natural gas liquids recovery are excluded. Fourth quarter production estimated in some instances. §Includes off-shore reserves. ¶Includes Alabama, Arizona, Florida, Maryland, Missouri, North Dakota, and Virginia.

small, in fact, that it is literally dwarfed by every net increase in gas reserves since 1946.

The 263,600,000,000 cu. ft. added to the reserves by the committee for 1954 is the first year since the reserves have been estimated that the net increase has dropped below 5 trillion cubic feet. In 1953 the net increase was more than 11 trillion cubic feet.

Once again it was in the extensions and revisions that reserve estimates took a beating. Sizable reductions in the category were made for Arkansas, Colorado, Montana, New Mexico, Utah, and Wyoming. New discoveries in Louisiana and Texas accounted for the lion's share of added reserves.

Canada Climbs, Too

Net increase in reserves 88 per cent of U. S. rise

CALGARY.—Canada added 372,397,000 bbl. to her reserves of total liquid hydrocarbons in 1954 and now has proved reserves of 2,415,945,000 bbl.

The reserves committee of the Canadian Petroleum Association said last week the reserve total went up in spite of a record production of 97,000,000 bbl. in Canada during 1954.

The committee said the reserve figures are proved recoverable petroleum in the ground. Figures do not include any estimates of oil which may be discovered later.

Canada's reserves include 2,207,614,000 bbl. of crude and 208,331,000 bbl. of natural-gas liquids. Her production last year was 95,616,000 bbl. of crude and 1,448,000 bbl. of natural-gas liquids.

The net increase in Canadian reserves of total liquid hydrocarbons was 88 per cent of the net increase in the United States. Canada's increase included 349,959,000 bbl. added in extensions and revisions of old fields and 119,504,000 bbl. in new fields and new pools in old fields.

Canada was able to boast a reserve increase near that of the United States in spite of the fact she drilled less than 7 per cent as many wildcats.

Canada's Proved Reserves

(In thousands of Imperial-gallon barrels which are equivalent to 42 U. S. gallon barrels)

Crude oil:

	Proved reserves as of 1-1-54	Extensions and revisions	New fields and new pools	Production during 1954	Proved reserves as of 1-1-55	Changes in reserves during 1954
Northwest Territories	26,442	100		370	26,172	—270
Alberta	1,624,496	374,533	16,835	87,385	1,928,479	303,983
Saskatchewan	182,159	—15,109	60,614	5,299	222,365	40,206
Manitoba	10,890	—300	20,670	2,133	29,127	18,237
Ontario and New Brunswick	1,435	365	100	429	1,471	36
Total Canadian crude oil	1,845,422	359,589	98,219	95,616	2,207,614	362,192
*Natural-gas liquids	198,126	—9,632	21,285	1,448	208,331	10,205
Total liquid hydrocarbons	2,043,548	349,957	119,504	97,064	2,415,945	372,397

*All natural gas liquids located in Alberta and British Columbia.

Note: Only a limited area is assigned to each new discovery. The committee is concerned only with actually proved reserves.

Industry Briefs

NEW YORK.—Houdry Process Corp. has developed a new high octane catalytic reforming technique, called the "Iso-Plus" process. Combining Houdriforming with aromatics extraction and thermal reforming, the new process will produce 100 octane clear reformate. Details of the new development will be revealed in a paper to be published in The Oil and Gas Journal next week.

SAN FRANCISCO.—Roy Ingersoll, president of Borg-Warner Corp., told a meeting of security analysts here last week his company's new sonic drill will be in production within 2 years. Some $5,000,000 will have been spent in the drill's perfection, Ingersoll said. It has been under development for the past 2 years.

BATON ROUGE. — Louisiana will grant only about a 9,200-bbl. per day increase in its April oil allowables. Conservation Commissioner John B. Hussey said the increase will care for new production. Other allowables and the depth bracket formula used in March will remain the same. March allowable totaled 684,412 bbl. per day.

AUSTIN.—A resolution urging that salaries of Texas Railroad Commissioners be increased from $10,600 to $20,000 a year has been introduced in the Texas Legislature. The resolution is in line with a proposal made recently by Jack Woodward, president of the Texas Independent Producers and Royalty Owners Association.

MIDLAND, Tex.—Shell Pipe Line Corp. will extend its West Texas crude-gathering system to take new production from Ropes field in Hockley County and from the Brahaney pool in Yoakum County. The company will lay a 22-mile, 6-in. trunk line from its Prentice station to Ropes pool, plus 3 miles of gathering line in the field. Shell also will lay 9 miles of 6-in. from Brahaney field to a connection with the Slaughter-Wasson line.

HENDERSON, Tex.—Stroud Brothers Oil Co., Joinerville, Tex., has bought four marginal producers on 253 acres of leases in Long Lake Woodbine field of Anderson County, East Texas, from Alex McCutchin estate, Dallas.

AUSTIN.—A bill has been introduced in the Texas Senate which would require a high bidder on any state mineral lease to pay the state an amount equal to 1 per cent of his bid. The lease fee would go into the state's general revenue fund, and the land commissioner would not issue a lease to the bidder until the fee was paid. Failure to pay the fee within 30 days after a demand by the land commissioner would be grounds for forfeiting the cash bonus.

PETTUS, Tex.—Danaho Refining Co. has placed a 1,000-bbl. Platformer on stream at its plant here. The new unit is part of a large-scale expansion program designed to boost the plant's throughput from 4,500 bbl. to 10,000 bbl. per day of crude oil.

WASHINGTON.—The National Petroleum Council will hold its spring meeting in Washington May 5. Chairman Walter S. Hallanan said reports may be ready on petroleum imports, oil and gas emergency defense, petroleum productive capacity and tank truck transportation.

WASHINGTON.—A map showing major natural-gas pipelines in the United States is now available from the Federal Power Commission. The four-color map, measuring about 13 by 19 in., shows major lines proposed as of last December 31 in addition to those in operation. Copies may be purchased from the FPC Publications Division for 25 cents each.

Gas Hearings Scheduled

Federal Power Commissioners may tip administration's hand in testimony before House committee this week

WASHINGTON. — Congress will get down to the job of amending the Natural Gas Act this week.

The House interstate commerce committee will open hearings on the Harris-Hinshaw bill to exempt independent producers from Federal Power Commission price regulation. Federal Power Commissioners will be the first witnesses. What they say is expected to be the tip-off on what the administration thinks about producer regulation.

The committee has a number of bills to study. In addition to the Harris-Henshaw bill, which follows the recommendation of the cabinet fuels committee and is supported by the industry, nearly a dozen other bills have been written.

Alternate bills . . . Included in the group are two bills brought in last week by Rep. John W. Heselton of Massachusetts. One bill would confirm the Supreme Court ruling in the Phillips case. The other would exempt the smaller operators from regulation, keeping only about 100 of the largest producers under FPC control.

Heselton believes his two bills would satisfy the demands of consumers for regulation of the industry without affecting many producers. He thinks, too, that FPC regulation of all producers would be very difficult from an administrative standpoint.

Two other bills would limit relief to the independents. Reps. Sidney R. Yates of Illinois and Charles A. Vanik of Ohio call for valuation of pipeline-company gas at actual cost. These bills are directed at the FPC's action last year allowing the fair field price for pipeline-produced gas. They do not provide for exemption of independent producers, but neither do they stand in the way of relief.

Prospects . . . Committee Chairman J. Percy Priest of Tennessee hopes the hearings can wind up in 10 days.

A short hearing would pave the way for getting a bill to the House floor by the middle of April. If the House passes the bill the Senate committee might take it up by the end of the month. Given a good break, the bill could go to the White House for approval about the end of May or early in June. But also it could be held up in the Senate for weeks.

Limitation of regulation to the big producers appears to be shaping up as the consumer representatives' big concession to get a compromise that will split the ranks of the gas industry. The idea was first put out by Sen. Paul H. Douglas of Illinois. Douglas said the little fellows didn't have to be regulated. More than 85 per cent of the gas marketed interstate comes from about 100 big producers.

No support from coal . . . Coal industry will not support the Harris bill. Instead, it will back a bill written by Rep. Harley O. Staggers of West Virginia, designed to protect coal against low-cost gas.

The industry isn't opposed to the Harris bill, Tom Pickett, executive vice president of the National Coal Association, said. It just doesn't go far enough and coal, railroads, and labor won't support it unless it is amended.

The Staggers bill does not cover the exemption of independent producers. It would give the FPC authority over direct industrial sales and would prohibit the dumping of gas at low prices for boiler fuel.

Rubber Sales In Home Stretch

Congress must act this week to kill any deals made by disposal commission; four congressmen voice opposition

WASHINGTON.—Sale of the Government's synthetic rubber plants faced its first big test in Congress last week.

Rep. Wright Patman of Texas asked the House to veto the sale. Under the disposal act itself, the measure could not be pigeonholed, and the rules committee sent it to the House floor even though the armed services committee had not finished its study of the sales program.

If any or all of the sales are to be turned down, Congress must act this week.

Patman, Rep. Emanuel Celler of New York and Rep. Sidney Yates of Illinois, lined up in opposition to the sales program in its entirety. Celler charged most of the plants were to be sold to companies which had been targets of antitrust suits.

Rep. Clyde Doyle of California also attacked the program. He questioned the "package" sale of three California plants to the Shell Chemical Corp. Shell bought a GR-S plant at Los Angeles, a butadiene plant at Torrance and the styrene plant at Los Angeles for $30,000,000. Doyle asserted the plants should have been sold separately.

The disposal commission explained that while offers were received on each plant from other bidders, Shell offered the best price. This was a special situation, it said. Its location put the GR-S plant at an economic disadvantage. Shell wanted an integrated operation and refused to take any one or two of the plants. The commission felt the interests of the Government and rubber consumers (Shell is not a rubber fabricator and will sell its entire output on the market) would best be served by the package deal.

Buyers of the plants, meanwhile, told House and Senate committees they would hold present prices on synthetic rubber. Several said they intended to increase plant capacity immediately. The industry will have to increase its output by 40 per cent by 1965, one rubber company officer said.

Celler charged that the buyers of 23 of the 24 plants have been or are now involved in antitrust suits. The only buyer in the clear is the Koppers Co., which is taking the alcohol butadiene plant at Kobuta, Pa., just to get the powerhouse and utilities, he said.

Celler urged the armed services committee to turn the sales down. But Chairman Carl Vinson of Georgia gave the program a clean bill of health.

Price War Probe Planned

WASHINGTON.—The Senate small business committee is going to investigate the why and how of gasoline price wars in New Jersey.

This is one of a number of probes planned by Chairman John Sparkman of Alabama after the House small business committee outlined its program for the session *(The Oil and Gas Journal, March 7, page 91)*. The House group will study the relation between service station operators and their gasoline suppliers, so the senators will dig into prices.

Lease Law Upheld

Ruling in Montana case may affect other states

WASHINGTON.—The Montana State Land Board now has authority to issue "open-end" oil and gas leases on federal-grant school lands.

The U.S. Supreme Court last week overruled a Montana Supreme Court decision which knocked out the state's indefinite-term lease law.

Final action approves the 1953 state law providing for oil and gas leases to run as long as production continues. That law permits the use of the lease form used by all major oil-producing states and the federal Government.

Settlement of the case is expected to open the way for greater leasing activity in Montana. The state has held only one lease sale since the law was carried to the courts 2 years ago.

The decision also is expected to have effect in North and South Dakota and Washington, whose school lands are in the same class as those in Montana. Both North and South Dakota intervened in the Montana case *(The Oil and Gas Journal, March 14, page 96)*. They contended the 1953 law should be upheld.

FCC Asks Power to Fine

WASHINGTON.—The Federal Communications Commission is asking Congress for legislation allowing it to slap cash fines on violators of radio rules. All the commission can do now is suspend the license or reprimand the violator.

The FCC says there has been marked increase in the number of violations since the war.

With the widespread use of radio throughout the oil industry offenses are bound to happen. In the future the careless company may have to part with a little cash to soothe the commission.

Experts Working Free

WASHINGTON. — Unpaid services from men in the oil industry make it possible for the Oil and Gas Division to operate on its limited funds, Director Hugh A. Stewart told a congressional appropriations committee.

Stewart said the OGD has $250,000 this year and is asking the same for fiscal 1956. He explained it will cost $20,000 this year to make security checks on consultants and men working on the Military Petroleum Advisory Board. This expense made it impossible to hire as many experts as wanted.

WATCHING WASHINGTON

Bertram F. Linz

Private Enterprise Case

The privately owned synthetic rubber industry hasn't yet been given a go signal by Congress, but it already is thinking of plant expansion.

And everything points to intense competition for the rubber market if the government plants pass to industry ownership late next month.

These points were brought out in recent hearings on the plant sales. They are a direct answer to charges that the new industry will be monopolistic and run in a "public-be-dammed" manner. They promise real enterprise, American style, as against the doubtful advantages of a government monopoly.

The new owners are going to pay more than $260,000,000 for the plants. They are smart men who don't spend that kind of money without first figuring what they are up against. So what they think is worth noting, and here is some of that thinking:

A lot more synthetic rubber will be needed by 1960. The buying companies are making studies to find out how much they will have to expand their plants.

The GR-S plants will be in keen competition for markets. The companies are trying to cement relations with present customers and will be looking for new ones.

Some companies already have set their selling prices. They are no higher than present government prices. If the competition gets really hot, they may go lower.

And one last point. Under government ownership improvements in product and technique could be applied in all plants. As a private enterprise, the company that comes up with a better or cheaper rubber will have an advantage over its competitors. Some improvements are on the fire now. Others will be dreamed up in company laboratories. There shouldn't be any lack of aggressive competition.

FPC Catches Up

The Federal Power Commission finally has caught up with filings by independent natural-gas producers of their June 7, 1954, prices.

More than 10,000 reports were filed. All of them have been looked at and most of them have been acted on, but it will be some time before all producers are formally notified. Some filings which were incomplete are still in the works.

The FPC now expects to be able to dispose of all new rate filings within the minimum 30-day notice period set by the Natural Gas Act. But it faces a tougher job of acting on applications from producers for certificates to sell gas to the interstate pipelines. More than 5,700 applications have been filed. Only 10 per cent of them have been disposed of.

It takes time to handle a certificate case. The commission has to hold a hearing on each application. Many cases are handled quickly with hearings lasting only a few minutes. But the minutes add up. And there are other bigger cases involving the pipelines that have to be heard, too.

There is a good possibility the independent producers may be taken away from the FPC, but it feels it has no choice but to go ahead with these matters. The Supreme Court ordered it to take over producer regulation, and that order must be obeyed until Congress says otherwise. So the producers will have to go on filing their rate changes and applications to sell for several months more, at least.

Antitrust Report Due

A Justice Department committee on antitrust law will make its report public next week. Signs are there will be no very drastic changes suggested. But some of its recommendations won't be palatable to the congressional small business committees.

Some of the report has leaked out. It appears to support oil industry practices which have been attacked by the Federal Trade Commission. Reportedly, the committee will say good faith should be a proper defense against charges of discrimination in competitive situations. It will say that delivered prices should be legal if not set up by agreement with competitors.

Other recommendations will be less favorable to industry. One may directly affect oil companies operating abroad; the committee is expected to say such companies should be subject to the antitrust laws. But it will say also they should be given the right to defend their actions.

Gas Escape Clause Tested

FPC must decide if producers can cancel contracts, escape regulation by using fuel in cycling program

WASHINGTON.—The Federal Power Commission is studying a vital natural-gas legal issue: Can producers cancel delivery contracts to use the gas in a cycling program and thereby escape federal regulation?

The FPC opened hearings last week on complaints of Texas Illinois Natural Gas Pipeline Co. It claimed 14 of its Texas suppliers in Clayton and La Gloria gas fields served notice they wanted to stop deliveries.

Contracts involved contained escape clauses allowing producers to stop deliveries if the FPC imposed regulation on them.

This is the first case involving this question to come before the FPC. Many producers, anticipating regulation, in past few years have insisted on including the escape clauses in their contracts with interstate pipelines.

Now the FPC must decide if the escape clause is legal. If it is upheld, a large number of contracts are expected to be canceled.

The complaints . . . Texas Illinois filed two complaints last September. One named Argo Oil Corp. and Magnolia Petroleum Co., gas suppliers from the Clayton area. The other named these and also Brown & Wheeler, Continental Oil Co., Fidelity Oil & Royalty Co., Mound Co., R. A. Welch, La Gloria Oil & Gas Co., Ohio Oil Co., Phillips Drilling Corp., Irene Sheerin and the John J. Sheerin estate, trustees under the Sheerin estate, Sun Oil Co., and Wiltex Corp.

The pipeline company contended the 14 producers are required to deliver over 80,000,000 cu. ft. of gas from La Gloria and 24,000,000 from Clayton daily.

The FPC at the opening of hearings refused requests of several producers to dismiss the complaints. The commission said its action did not violate the stay issued by the Fifth Circuit Court of Appeals to Magnolia and Sun during review of FPC Order No. 174-A.

The FPC then issued formal summonses to Magnolia, Socony-Vacuum Oil Co., La Gloria, and the Goliad Corp. These companies have other contracts which the commission thinks enter into the picture and are needed to get full details of all operations in the two fields.

Texas approves cycling . . . Meanwhile, the cycling plans which brought the test case before the FPC were approved last week by the Texas Railroad Commission.

The agency approved plans of Magnolia and other operators to carry out pressure maintenance operations in several of 21 oil zones in La Gloria field.

The $2,000,000 program is expected to net an extra 5,000,000 bbl. of oil from the field *(The Oil and Gas Journal, February 28, page 89).*

Line Nearly Ready

SEC approval only hurdle facing Pacific Northwest

WASHINGTON. — Only one detail bars construction of a natural-gas pipeline from the San Juan basin to the Pacific Northwest. It is Securities and Exchange Commission approval of a $163,000,000 financing plan filed last week by Pacific Northwest Pipeline Corp.

The SEC was asked to approve a registration of $93,200,000 in 20-year first mortgage bonds, $26,800,000 in unsecured notes to banks, $17,220,000 in interim notes, and an issue of common stock.

Some of the common stock would be issued, at the company's option, to Phillips Petroleum Co. in payment of $5,654,000 in unsecured notes.

Pacific Northwest told the commission it is ready to begin construction and can complete the initial system by the summer of 1956. Orders for 90 per cent of the pipe needed have been placed with Kaiser Steel Corp. and Consolidated Western Steel Corp. Additional equipment has not been ordered, but can be secured without delay, the company said.

Aerial survey and mapping of the route are almost finished. The company will start drilling wells, acquiring station and plant sites and contracting for equipment as soon as securities are sold.

The registration statement showed that the company will pay 22¼ cents per M.c.f. for gas to be received from Westcoast Transmission, Ltd., at the Canadian boundary beginning November 1, 1957. That price will hold until January 1, 1959, when it will drop to 22 cents per M.c.f. for the balance of the 20-year contract.

The arrangement to take Canadian gas calls for the sale of gas to the El Paso Natural Gas Co. by Pacific Northwest at 25¼ cents per M.c.f. until January 1, 1959, and 25 cents per M.c.f. thereafter *(The Oil and Gas Journal, December 20, 1954, page 58).*

The company is to build a 1,466-mile pipeline from Ignacio, Colo., to Bellingham, Wash. The Federal Power Commission also has authorized it to build 433 miles of supply lines and sales laterals, drill and operate wells, and put a gathering system in the San Juan basin in New Mexico and Colorado, the Big Top field in Wyoming and the Piceance Creek and Bax-X fields in Colorado, with processing and dehydration plants.

Military Policy Changed

WASHINGTON.—The military services are striving to put their estimates of oil requirements on a more realistic basis to help small suppliers working on open-end contracts.

First steps have been an extension of the contract period from 6 months to 1 year on certain products and placing on a firm basis orders for products packed in small containers.

Col. Arnold C. Gilliam, director of the Armed Services Petroleum Purchasing Agency, said that for most products the open-end contract is the most feasible way of meeting military requirements.

Under this type agreement, the military can take up to a certain amount of a product over the contract period but is not required to take it all. Suppliers—especially the smaller ones—run into difficulties when ASPPA actually takes much less than it estimated would be needed.

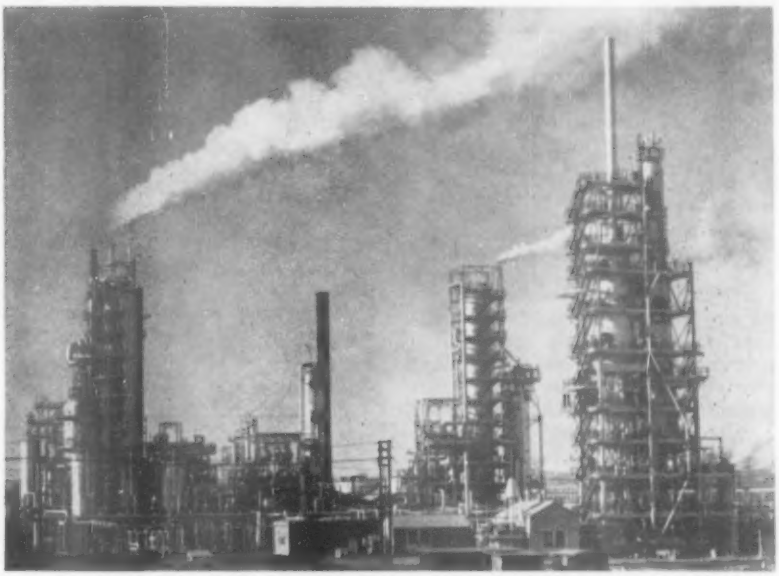
Plant Closing Delayed

WASHINGTON.—A delay has been ordered in closing the government's experimental shale-oil plant at Rifle, Colo., so current research may be completed.

Asst. Interior Sec. Felix E. Wormser reported the department plans now to shut down the plant about June 30 despite attempts by congressmen from Rocky Mountain states to block the move.

Wormser said Union Oil Co. of California plans to spend $5 to $7 million on a plant near Rifle. It would handle 1,000 tons of shale a day compared with 150 tons at the governmental station. If the experiment is successful, Union plans to build a commercial plant.

Wormser estimated it would take 10 to 15 years to get oil-shale products on a competitive basis with petroleum.



FLUID COKER, at right, introduces new refining technique.

Yield Picture Brightened

First commercial fluid-coking unit boosts gasoline yield at Carter Oil Co. refinery 1,775 bbl. daily

BILLINGS, Mont.—The world's first commercial fluid-coking unit, dedicated last week, has brightened the yield picture at Carter Oil Co.'s refinery here.

The plant is capable of converting 3,800 bbl. per day of residual oil to gasoline, middle distillates, and fluid coke. First placed on stream several weeks ago, the unit is now in routine operation.

The trail-blazing process is a development of the affiliated Esso Research & Engineering Co. Besides Carter's unit, five others have been licensed. In all, they will have a charging capacity of 83,600 bbl. per day.

Process . . . Fluid coking uses the fluidized solids technique used in catalytic cracking *(The Oil and Gas Journal, August 17, 1953, page 74)*. But here the coke itself is fluidized. In the reactor vessel, the residual feed stock is charged to a fluidized bed of hot coke particles. The heavy hydrocarbons are thermally cracked, yielding light ends, gasoline, and fuel oils, which are withdrawn from the reactor after passing cyclone separators. Heavy gas oil from the fractionator is recycled to the reactor with fresh feed.

The coke which is formed in the thermal-cracking process is laid down on the finely divided coke particles. A stream of coke is continuously withdrawn to a second vessel, the coke burner. Here it is fluidized with air, and a portion of the coke is burned.

A fraction of the unburned, heated coke particles is returned to the reactor to provide the temperature necessary to carry out the thermal cracking of charge stock. New coke production is withdrawn from the burner vessel as a stream of hard, glossy coke grains which correspond roughly in size to the sand in an hourglass.

Yield . . . Before the fluid coker was installed, Carter's 25,000-bbl. refinery included primarily a two-stage crude unit and a fluid catalytic cracking unit. The accompanying table shows how the yield has changed.

HOW COKER CHANGED YIELD

	Per cent yield, Elk Basin crude	
Refinery product—	Without coker	With coker
Motor fuel	40.0	47.6
Light fuel oil	26.9	26.9
Heavy fuel oil	3.1	6.2
Asphalt and road oil	6.9	6.9
Residual fuel oil	15.0	
Coke		1.4
Consumed as plant fuel	8.1	11.0

On the average, since the coker was installed, a refinery run of about 23,330 bbl. of crude per day has produced 3,500 bbl. per day of heavy vacuum bottoms. Roughly half of this low-valued product now winds up as high-octane gasoline produced by catalytically cracking the coker distillates. This net improvement in gasoline yield amounts to 1,775 bbl. per day.

Trend . . . Total coke production from the reactor runs about 200 tons per day. Of this, about 40 tons is burned in the unit to maintain proper coking temperature, and the remainder is marketed.

The first commercial fluid coke is now being tested in a number of experimental and commercial installations. Some has been shipped to New Jersey where it has proven a satisfactory fuel when pulverized and burned with powdered coal by a large utility company. Some is undergoing further testing for alternate end uses, at the Battelle Memorial Institute.

Carter's new unit is the first of several to be built in this country and Canada. Esso Standard Oil Co. is building a 10,000-bbl. unit at Baltimore and a 20,000-bbl. one at Baton Rouge.

Aurora Gasoline Co., the first outside the Jersey family to license the process, is erecting a 4,000-bbl. unit at Detroit. Canadian Petrofina, Ltd., is adding a 3,800-bbl. unit to its new Montreal refinery. The biggest yet announced will be the 42,000-bbl. giant which Tide Water Associated Oil Co. will incorporate in the new 130,000-bbl. per day refinery to be built in Delaware. Another unit is slated for the West Coast.

Right-of-Way Case Appealed

DENVER.—The U. S. Tenth Circuit Court here has been asked to decide whether Union Pacific Railroad can legally drill for oil on its right-of-way at Borie Junction, 11 miles west of Cheyenne, Wyo.

Appeal of a Cheyenne Federal District Court decision allowing the drilling was filed last week.

District Judge T. Blake Kennedy ruled the federal Government did not retain mineral rights when it granted the railroad the right-of-way in 1862 and 1864 *(The Oil and Gas Journal, January 10, page 60)*.

The case affects rights-of-way extending from the Missouri River to the Pacific Ocean.

Crude Line Planned

CHEYENNE, Wyo. — Big Horn Pipeline Co. last week asked authority to build a 150-mile, 8-in. crude line from Ash Creek field to a connection with Service Pipe Line Co.'s line at Midwest, Wyo.

Big Horn is a new partnership formed by William J. Kirvin and Henry A. Burgess.

The company's application, filed with the Wyoming Public Service Commission, said the line would move crude produced by 35 wells in Ash Creek field, pick up crude from fields north of Kaycee, Wyo., and handle additional crude from Tisdale Mountain.

East Poplar Flow Curbed

HELENA, Mont.—The State Oil and Gas Conservation Commission has limited daily production in Montana's East Poplar field to 150 bbl. of oil per well.

Maximum efficient rate of production was set last week following hearings at Poplar. The board said heavy withdrawals were endangering field pressures. Condition of each well is to be reviewed following a pressure survey.

Of the 31 wells in the field, 20 are owned by Murphy Corp. Empire State Oil Co. owns five; C. C. Thomas, four; and Wagner & Christenson, two.

Nebraska Tax Bill Opposed

LINCOLN, Neb.—Nebraska oil men are opposing a bill introduced in the state legislature to levy a 2 per cent severance tax on natural-gas and crude production. The revenue would be earmarked for the permanent school fund.

Oil men contend the industry, comparatively new in Nebraska, would be hindered by the new tax and that exploration would be curtailed.

GULF COAST

New Plants Booming

72 petrochem projects under way on Gulf Coast

BEAUMONT. — The petrochemical industry is pouring $571.4 million into new plant construction along the Texas Gulf Coast.

The 72 projects either on the planning boards or under construction will boost Texas into the No. 2 spot in domestic chemical production—up two rungs from its present fourth place.

Gordon H. Turrentine, assistant general manager of the Houston Chamber of Commerce, pointed up this rapid growth in an address before a joint meeting of the Sabine area sections of the American Institute of Chemical Engineers and American Chemical Society.

Turrentine said plant construction on the Gulf Coast accounted for more than one-third of the $1.5 billion being spent on chemical plants throughout the nation.

This region, extending along the Gulf Coast as far as Lake Charles, La., accounts for 75 to 85 per cent of the nation's petrochemical production capacity, he said.

Total investment in chemical plants alone had reached $1.162 billion on January 1, 1954. These figures did not include the present construction program of polyethylene plants involving a multimillion dollar investment by several companies.

Turrentine reported a survey made by the Southern Association of Science and Industry showed this disposition of funds for the 72 Texas projects:

Polymeric materials—$225.4 million.

Other synthetic organic chemicals—$115.9 million.

Agricultural chemicals—$86.3 million.

Petroleum and natural gas chemical —$29.5 million.

Sulfur and sulfuric acid—$17.7 million.

All other chemicals and facilities—$96.6 million.

Offshore Bids Watched

WASHINGTON.—The oil industry will reveal this week whether the high interest shown last year in leases on the outer Continental Shelf off Louisiana is still alive.

The Interior Department March 25 will open nominations for a lease sale to be held in midyear. Officials said they hoped companies whose bids did not get leases last year will show an interest in other areas.

Edward Woozley, director of the Bureau of Land Management, said he did not expect much from companies getting leases last year on bonuses running into millions of dollars. He added, however, that if any of the new lessees strike oil, the department will have little trouble selling more leases.

Interior Secretary McKay said he was confident the industry within a year will learn how to drill even in the deepest water so far leased.

WEST COAST

Offshore Lease Bids Asked

LONG BEACH.—Bids on two submerged tracts in the Long Beach Harbor area have been requested by the Board of Harbor Commissioners. Opening date for the sealed bids, which will be for 10 years, was set for May 17.

The tracts, one of 876 acres and the other of 550 acres, lie south and southeast of developed portions of Wilmington field. Development will be by wells slanted from Victory Pier and Pier A. Some of the deeper pays may be present, but it is expected that only the Ranger zone will be productive throughout the area.

The development contracts will provide for secondary recovery through the use of water and gas injection. They are based on those under which Richfield Oil Corp. and Long Beach Oil Development Co. operate.

Long Beach Decision Due

SACRAMENTO.—California's Supreme Court will probably decide this month whether Long Beach can spend its tidelands oil income for upland improvements.

The Supreme Court is expected to hand down its decision in the so-called Mallon suit March 28. The suit claims that under the terms of the grant of the submerged lands to the city, any income must go only for harbor improvements. The court decision will vitally affect a bill now before the legislature which would take the oil and gas income from Long Beach.

Hard-Luck Rig in New Test

BAKERSFIELD, Calif.—The big rig used by Ohio Oil Co. to set the world's depth record of 21,482 ft. at Paloma field near here is scheduled for its fifth effort to find oil in its 8-year life.

The company-owned rig will be used by Ohio for a wildcat in the mountainous region between Ventura and Cuyama Valley.

After drilling a 11,000-ft. Michigan test in 1947-48, the rig was brought to California. It drilled a 13,800-ft. dry hole near Arvin. After spending the next 3 years on the Paloma well, the rig was moved last December to Belgian Anticline. It drilled an 8,063-ft. dry hole there.

The new wildcat will be in Cherry Canyon at an elevation of about 4,500 ft. Scheduled depth of this test, on the Ortega anticline, is 7,000 ft.

Line to be Changed

Magnolia will move L.P.G. from Midland to Beaumont

DALLAS.—Magnolia Pipe Line Co. will convert a 540-mile, 8 and 10-in. crude line from Midland to Beaumont, Tex., to L.P.G. service by January 1, 1956.

The converted line will take an unfractionated L.P.G. stream from the Magnolia-operated Pegasus Unit gasoline plant in Pegasus field and from El Paso Natural Gas Co.'s Midkiff plant in Spraberry Trend Area field. Other plants may use the line later.

Conversion work cannot begin in earnest until Magnolia Pipe Line completes an expansion of its Midland-Corsicana crude system.

The program, announced 2 weeks ago *(The Oil and Gas Journal, March 14, page 90)*, involves laying 12, 14, and 16-in. pipe to fill in gaps between loops on this system and will give the company two complete lines of 12-in. and up between the two towns.

Capacity of the 8 and 10-in. line will be needed until this work is finished in early fall. Construction contracts for most of the work were let last week. O. R. Burden Construction Corp., Tulsa, was awarded contract for 83.5 miles of 16-in. and 6.75 miles of 12-in. from Corsicana to De Leon, and H. B. Zachry Co., San Antonio, will lay 17.95 miles of 16-in., 14.20 miles of 14-in., and 60.14 miles of 12-in. line between De Leon and Midland.

L.P.G. line . . . The L.P.G. stream will be piped through an 8-in. line to Corsicana and through a 10-in. line on into Magnolia Petroleum Co.'s refinery at Beaumont. New facilities at the refinery will separate the stream into various L.P.G. products. The butane and propane will be moved through existing lines to the company's underground-storage operation at Hull, about 30 miles to the west.

The Hull storage project already is being expanded to take care of the new L.P.G. load from West Texas. Magnolia is drilling a new storage well in the Hull salt dome and will drill more wells before the end of the year to establish a whole system of storage cavities for the various products.

The conversion of the crude line to L.P.G. service and the expansion of the Hull storage project are portions of a long-range Magnolia program to bring West Texas L.P.G. products to the Gulf Coast for use in heavy industry or for export.

A Magnolia Pipe Line official said the line, which has been carrying about 28,000 bbl. of crude oil daily, could possibly handle up to 25,000 bbl. of L.P.G. a day. The company, however, is "looking at" a figure of around 20,000 bbl. daily.

New pump stations may be built at Itan and De Leon, Tex. All conversion work, including revamping and building pump stations, will be handled by company personnel.

Texas Eyes Price Bill

Measure would let Railroad Commission set gas prices

AUSTIN.—A new bill authorizing the Texas Railroad Commission to set minimum prices for gas produced in Panhandle field has been referred to the Texas Senate's oil, gas, and conservation committee.

Sen. Grady Hazelwood, who introduced the measure, said it was designed both to rectify hardships on land and royalty owners and small producers and to halt wasteful production practices which he said have resulted from unrealistically low prices in the field.

Much of the gas in the field, he said, is sold for only 3.6 cents per M.c.f. as compared with prices of 15 cents elsewhere. The gas is going at such a price because sale contracts were signed as long as 27 years ago for the life of the field when there was no competition for the purchase of the gas.

Such low prices, he said, have resulted in early abandonment of wells long before recoverable hydrocarbons were extracted, in failure to drill flank or edge wells, and in the loss of "millions of dollars in taxes rightfully belonging to the state."

Terms . . . The bill would give the Railroad Commission considerable freedom in setting the minimum price. It does not recommend a specific price and would permit the commission to divide the surface area of the field into separate zones if it wished.

The minimum price would be fixed at the point at which the gas was sold, whether this be at the wellhead, at a central gathering point, or at the outlet of a gasoline plant.

The bill conceivably could take in fields in the state other than Panhandle as it is now worded. It authorizes the commission to fix minimum prices in each field with a surface area of 600,000 acres or more and producing both sweet and sour natural gas when necessary to prevent waste. The large field size apparently would eliminate fields other than the Panhandle except for one clause.

This reads: "The area comprising fields which adjoin each other shall be deemed to be a single field for the purposes hereof." This, depending upon the interpretation of the word "adjoin," could be construed to mean that the commission had the authority to set minimum gas prices in any large gas area in the state.

Injection Started

Secondary-recovery project is third largest in Texas

LEVELLAND, Tex.—One of the largest unitization and secondary-recovery projects in Texas has been started at Levelland field near here.

Stanolind Oil & Gas Co., as operator of the 16,207-acre unit, started injecting gas into the San Andres formation late last month. The unit includes 368 wells and 18 injection wells.

During early stages of operation gas will be injected into the producing formation at the rate of 3,000,000 to 4,000,000 cu. ft. per day, according to Harry V. Mathews, superintendent of Stanolind's gasoline plant here. Capacity of the plant will permit increasing the volume of gas injected if desired.

Mathews said only gas taken from the field in current production will be returned to the producing formation.

In seeking Texas Railroad Commission approval of the project, Stanolind estimated it would result in the recovery of up to 16,000,000 bbl. of additional oil *(The Oil and Gas Journal, April 12, 1954, page 92)*.

As originally proposed, however, the project would have included a maximum of about 21,500 acres, which is shown in black on the accompanying map.

Levelland field covers approximately 75,000 acres in Hockley and Cochran

counties, West Texas. The gas-injection unit is in the eastern part of the field.

Only two secondary-recovery programs in Texas are larger than the Levelland unit. They are in Kelly-Snyder and Goldsmith fields.

Levelland field was discovered in 1945. The area covered by the unitization agreement has been developed since 1951.

Imbibition Extended

Tex Harvey Spraberry test approved for another year

AUSTIN.—The Texas Railroad Commission has extended for another year Tex Harvey Oil Co.'s experimental water-imbibition project in the Tex Harvey area of Spraberry Trend Area field.

The imbibition flood takes in 3,920 acres and 68 wells. Tex Harvey in the near future will increase the number of injection wells from the present 5 to 11 and hike the injection rate from 500 to 750 bbl. daily per well.

While testifying at a commission hearing on the expansion early in March, Arthur Harvey, owner of Tex Harvey, predicted that the entire Spraberry Trend Area field eventually will be flooded by the imbibition method. He said probably about half the wells in the huge 500,000-acre field would be used for injection, the other half as producers.

The Tex Harvey project is one of three being conducted in the tight Spraberry sand in the area. The others are operated by Atlantic Refining Co. and Humble Oil & Refining Co. Atlantic's was the first. Though results of this experiment have not been highly spectacular, oil recovery has been increased substantially. Atlantic recently obtained approval to extend its flood for another year.

Humble is trying what it terms a conventional water-flood operation in the Spraberry under its 1,320-acre Shackelford "B" lease. Other operators, however, say this project is identical to the two imbibition operations.

Tex Harvey began injecting water in June 1954. Roughly 700,000 bbl. of water has been injected since then. Oil production from the experimental area totaled more than 2½ million barrels as of January 1.

Commission Asks Advice

AUSTIN.—The Texas Railroad Commission has asked all major purchasers of Texas crude for opinions on desirable levels of crude and product stocks for the spring and fall seasons.

Purchasers were asked to send representatives to the state-wide oil and gas proration hearings here March 18 to make their reports.

The last hearing of this type was held in March 1954. The commission uses the information gleaned from such hearings as an aid in setting crude production allowables.

Tax Refunds May Be Killed

AUSTIN.—A drive is gaining ground in the Texas Senate to head off any refunds of tax revenue paid by gas companies which did not protest the Texas "gas-gathering" tax before it was ruled unconstitutional by the United States Supreme Court last year. These payments came to $6,300,000.

Sen. Dorsey B. Hardeman is leading the fight to defeat numerous resolutions introduced on behalf of companies which would allow them to sue the state for refunds. It is a mistake, Hardeman says, to allow the companies to sue the state when they declined to take advantage of the payment-under-protest statute.

CANADA

In latest Saskatchewan sale . . .

Net Royalty Bids Replace Bonus

REGINA.—Net royalty bids, rather than cash bonuses, were the thing in Saskatchewan's latest lease sale of crown reserve acreage.

After the most competitive sale the province has held, the Department of Mineral Resources accepted eight net royalty bids and only one cash bonus offer. The bids covered 9 of 11 parcels of proved and semiproved acreage in the Dollard and Cantuar medium gravity oil fields in southwestern Saskatchewan.

The department deferred a decision on bids for one parcel and rejected all bids for another.

Net royalty bids, a new thing in the provincial lease sales, ranged from 30 per cent for one Dollard parcel to 77.3 per cent for a tract in the Cantuar field. The lone cash bid was slightly more than $36.41 an acre for a section in Cantuar.

The sale attracted more bids than any held before. Twenty-four companies made 67 bids on the 11 parcels. It was also the first sale to attract offers from companies not already active in the province.

The high bids . . . The lone cash bid accepted was made by Woodley Canadian Oil Co. for a section in the southeast corner of Cantuar field, offsetting production to the east. The total bid was $20,138.

Whitehall Canadian Oils, Ltd., bid 77.3 per cent royalty for a section on the north side of Cantuar offsetting production to the east, west, and south. There is a dry hole to the north. Whitehall also got a section in the center of the same field for a net royalty bid of 71 per cent. This tract is surrounded by production and drew 16 bids.

Next highest royalty offer was 65 per cent submitted by D. D. Feldman Oil & Gas, Dallas, Tex. This bid bought a section in the southeast corner of Cantuar with production to the north and west.

Top successful bidder in Dollard field was Frontier Refining Co., Denver, whose bid of 52.83 per cent bought a section in the southwest corner of the field. There is production to the north and east.

The Tide Water Associated Oil Co. group, discoverers of the field, has done the only drilling in the field so far. The group has drilled 26 wells. This

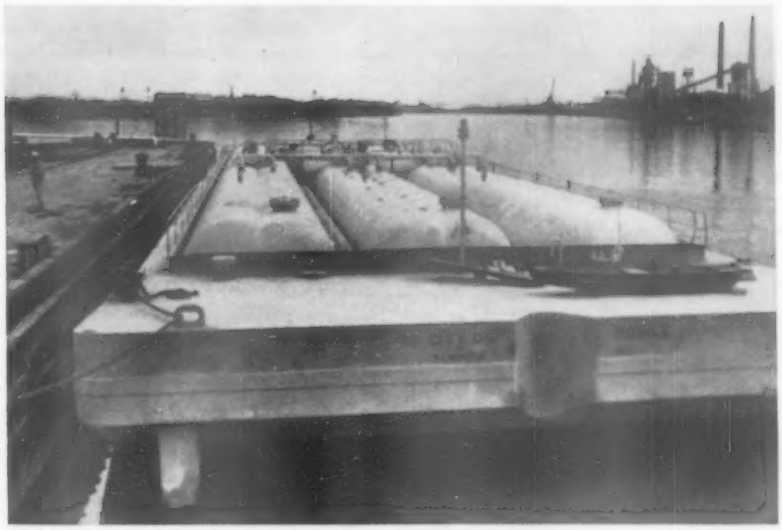
Saskatchewan's Successful Bidders

CANTUAR FIELD

Description and Successful Bidder—	Bid
Sec. 29-15-16w3, Woodley Canadian Oil Co.	$20,138
	Per cent
Sec. 36-15-17w3, General American Oil Co.	57.5
Sec. 1-16-17w3, D. D. Feldman Oil & Gas	65
N½ 4-16-17w3, Woodley Canadian Oil Co.	40.1
Sec. 11-16-17w3, Whitehall Canadian Oils, Ltd.	71
Sec. 16-16-17w3, Decision deferred	Deferred
Sec. 22-16-17w3, Whitehall Canadian Oils, Ltd.	77.3
Sec. 18-16-16w3, Rejected	Rejected

DOLLARD FIELD

Sec. 3- 7-20w3, Nuco Petroleums, Ltd.	30
Sec. 12- 7-20w3, Tide Water Associated Oil Co.—Operator	40
Sec. 16- 7-20w3, Frontier Refining Co.	52.83



Phillips Moves Ammonia From Houston Port

This barge recently provided the Port of Houston with the first water movement of anhydrous ammonia originating there. The ammonia was produced in the 465-ton per day plant placed in operation at Adams Terminal in 1953 by Phillips Chemical Co., a wholly owned subsidiary of Phillips Petroleum Co. The initial 800-ton shipment was destined for Mid-South Chemical Co.'s new distribution center near Memphis. Phillips also has started moving anhydrous ammonia from Adams Terminal by ocean-going barge. First such shipment was 1,300 tons destined for Puerto Rico.

group got a section for a 40 per cent royalty bid.

Terms . . . Under the net royalty lease offered by the government, accounting is in two phases. During the first, or payout phase, the operators pay a straight 12½ per cent gross royalty and retain the balance of income from production until development expenses have been recovered.

After the payout, the operators pay the government the same gross royalty and deduct operating expenses, plus $500 yearly per well for tangibles. These items are deducted from gross oil sales and the net royalty bid is on the remaining net proceeds of each well.

Gas Line to Feed New Plant

EDMONTON.—A $1,000,000 gas pipeline system linking Etzikom gas field with a proposed chemical fertilizer plant near Medicine Hat in southeast Alberta will be built by New British Dominion Oil Co., Ltd., in partnership with Midcon Oil & Gas, Ltd.

T. L. Brook, New British Dominion president, said initial delivery of the line would total about 9,000,000 cu. ft. daily. Delivery will be increased to 15,000,000 cu. ft. daily within 7 or 8 years without plant expansion.

Brook estimated initial needs of the planned Northwest Nitro-Chemicals, Ltd. plant at 6,000,000 or 7,000,000 cu. ft. daily. Arrangements also are under way to market an additional 3,000,000 cu. ft. daily to the city of Medicine Hat.

The chemical plant will manufacture high analysis nitrogen and phosphate chemical fertilizers. It will represent an investment of $22,000,000 with New British Dominion and Commercial Solvents Corp. the major equity holders. Also associated in the venture are Ford, Bacon & Davis, Inc., and Frank McMahon.

Sturgeon Lake Line Pending

CALGARY.—A syndicate of several oil companies reportedly has won permission to lay a crude pipeline linking the Sturgeon Lake Devonian field with Trans Mountain Oil Pipeline near Edson, 120 miles west of Edmonton.

Peace River Pipe Line Co., Ltd., is expected to be granted the permit. Others in the financing group are Canadian Gulf Oil, Shell Oil Co., Imperial Oil, Ltd., Amerada Petroleum Corp. and Union Oil of California.

Imperial Tests Promising

ESTEVAN, Sask.—Oil shows have been found in two wildcats being drilled by Imperial Oil, Ltd., in the Carnduff area of southeastern Saskatchewan.

A drill-stem test of the Mission Canyon (Mississippian) in Imperial Antler River recovered 200 ft. of oil and 10 ft. of salt water. The test was made at 3,915-26 ft.

The well is 5½ miles northwest of Carnduff, 9 miles southwest of Imperial Mississippian production in the Nottingham area, and 12 miles south of the Alida Mississippian field.

Seven miles farther south, Imperial had oil shows in two drill-stem tests at a wildcat on acreage farmed out by Canadian Superior Oil of California, Ltd. The well is Imperial-Canadian Superior Carnduff.

Seaboard Acquires Farmout

REGINA, Sask.—Seaboard Oil Co. has taken a farmout on Crown Permit 451 in the Gull Lake area of southwestern Saskatchewan from Canadian Devonian Petroleums, Ltd., Regina.

Terms of the deal have not been announced officially, but it is understood Seaboard will earn 50 per cent interest in the 44,320-acre permit by bearing full costs of three to five exploratory wells. There was no cash transaction, and no geophysical work is called for. Seaboard is expected to start drilling the acreage by the end of March.

The acreage is 4 miles southwest of the Gull Lake Jurassic medium-gravity oil field, 6 miles southeast of the Socony-Woodley-Southern Tompkins 30-14 Jurassic natural-gas strike, and 6 miles northwest of the Delhi-Phillips-Richfield Bone Creek Jurassic oil find. It is about 40 miles southwest of Swift Current.

El Paso Gas Gets Farmout

DALLAS.—Fargo Oils, Ltd., has farmed out 1,250,000 acres of its leases in British Columbia to El Paso Natural Gas Co., El Paso, Tex.

El Paso will explore and develop the acreage for oil and gas. Fargo, a subsidiary of General American Oil Co. of Texas, Dallas, will be paid half the proceeds from sale of any oil or gas production developed after El Paso deducts expenses.

R. M. Swesnik, Fargo president, said his firm is retaining its approximate 18 per cent interest in the White-Lloyd prospects in British Columbia and production in the Lone Rock area of Saskatchewan.

Calgary Firms Merge

CALGARY.—Shareholders of Alberta Pacific Consolidated Oils, Ltd., and Sunset Oils, Ltd., two Calgary independents, have voted to merge into a single operating company.

The agreement called for Alberta Pacific Consolidated to absorb all assets of Sunset and issue one share of its stock in exchange for each Sunset share.

Jersey Enters Sicily

Standard acquires interest in lease blocks totaling 215,000 acres; initial drill tests planned May 1

STANDARD OIL CO. (N. J.) has entered the exploration play in Sicily by taking an interest in three exploration blocks near Catania and Augusta.

Jersey Standard's Italian partner in the venture is Raffineria Siciliana Olii Minerali (RASIOM), a private company which operates a 40,000-bbl. daily refinery at Augusta.

An operating company, Augusta Ricerche Petrolifere, S.p.A., has been organized, and an initial test of the acreage is planned to begin about May 1. The acreage is held under 3-year exploration permits issued by the Sicilian regional government and covers 215,000 acres.

H. F. Belding, formerly in geological work with International Petroleum Co., Ltd., in Colombia and Peru, has been shifted from Jersey Standard's exploration department in New York to become managing director of Augusta Ricerche Petrolifere.

Other executives of Augusta Ricerche Petrolifere include two officials of Jersey Standard's Italian marketing affiliate, Esso Standard Italiana, S.p.A. They are Dr. V. Cazzaniga, president, and Dr. S. Cerulli-Irelli, director. Directors of Augusta Ricerche Petrolifere representing RASIOM are A. Moratti and S. Zuco.

Favorable climate . . . Although politically a part of Italy, Sicily has its own separate petroleum law which is much more favorable to private capital. Legislation governing exploration on the Italian mainland gives a monopoly in the Po Valley to the government company, Ente Nazionale Idrocarburi, and elsewhere specifies terms that most foreign operators have found unacceptable.

Jersey Standard is the third large foreign company to take advantage of Sicily's more liberal legislation. Gulf Oil Corp., through its own American International Fuel & Petroleum Co., and jointly with Macmillan Petroleum Corp., has been exploring in Sicily for several years, as has British Petroleum Co., Ltd., subsidiary, D'Arcy Exploration Co., Ltd.

Gulf's discovery about a year ago of what is expected to be a major field at Ragusa has raised a high degree of interest in the further prospects of the island. Even before the Gulf discovery, a number of Italian operators, including RASIOM and a subsidiary of the Italian Government's ENI, took out acreage in Sicily. The Italian Government organization has been developing some gas production in the Catania area. Little good exploration acreage not already covered by concession remains in Sicily.

D'Arcy found low-gravity oil in a wildcat test near Vittorio at about 6,500 ft. This company recently began exploration work in the area between Vittorio, Acate, and Caltagirone. Gulf meanwhile is continuing exploratory drilling as well as development work at Ragusa where it has some four wells each good for 500-600 bbl. daily of about 20°-gravity crude. This oil is being shipped to RASIOM's Augusta refinery to supplement the normal charge of Middle East crude.

Italy under scrutiny . . . Jersey Standard, Caltex, and other companies are closely watching political developments in Italy itself where there is renewed talk of changes in the oil law. There is some possibility that new legislation will be introduced before the current session of the Italian Parliament ends next June.

Jersey Standard sought for many years to carry out large-scale exploration in the Po Valley. In 1927 it bought control of a small Italian company, Soc. Petrolifera Italiana, and subsequently developed minor oil and gas production.

The Italian Parliament early in 1953 decided the long-standing controversy over state vs. private operations by passing a law establishing the ENI monopoly in the Po Valley. Last summer, Jersey Standard sold out its majority interest in SPI, thus ending its exploration and producing activities on the Italian mainland.

Not enough slices in . . .

. . . Iranian Oil Melon

THE $64 question in the international oil business last week was how 12 will be divided into 5.

When the Iranian consortium was organized last year to settle the nationalization dispute, each of the five American participants agreed to give up 1 per cent of its interest to other responsible and qualified United States oil companies.

When the list came out earlier this month, there were 11 companies approved for a share of the open 5 per cent. They ranged from relatively small producers to some of the country's largest integrated companies *(The Oil and Gas Journal, March 14, page 98)*. A twelfth company reportedly has been certified since then.

Each of the companies certified by Price Waterhouse & Co. to the State Department was found eligible to handle from 1 on up to the full 5 per cent. Altogether, the companies were certified for about 40 per cent.

Possible solutions . . . The headache that presented itself last week was how the requests will be trimmed. The eligible applicants are supposed to get together and work out some kind of independent Iranian oil firm, and the State Department obviously was hoping that the companies themselves will be able to decide their separate shares. This was the way it was planned originally.

There was much speculation last week over what the outcome will be. The Iranian agreement provides that the available 5 per cent will be transferred and the new partners brought in 6 months after the ratification October 29. This makes the deadline April 29, less than 6 weeks off.

So far, little progress has been made by the certified companies on their joint participation. Several possibilities were being talked:

. . . Some of the companies may drop out. This happened when the American share in Iraq Petroleum was set up. Two companies, Sinclair and Texas, withdrew before negotiations were completed in 1928, and three others, Gulf, Atlantic, and Pan American Petroleum & Transport, sold out later. This left the present two American partners, Socony-Vacuum and Jersey Standard.

. . . The 5 per cent could be split evenly among the companies, without regard to financial resources, need for oil, per cent certified, etc. This would give each of the group one-twelfth of

5 per cent, or a little less than half of 1 per cent. When production builds up to the planned 600,000 bbl. daily in 3 years, each of the independent participants would have access to about 3,000 bbl. daily, roughly half of which would be in products from the Abadan refinery.

. . . Available share could be broken up and distributed among the applicants on some kind of weighted basis, perhaps on the percentage for which they were certified.

There was general agreement last week that the matter of settling the independents' participation may require a solution as ingenious as that which brought about the formation of the consortium and the settlement with the Iranian Government.

Speculation . . . Another point of considerable interest was the likely use some of the companies will make of the oil to be acquired as a result of their participation.

Those with seacoast refineries in the United States will probably import crude. The products could be turned over to one of the larger companies or disposed of on markets in the Eastern Hemisphere.

Of the 11 companies originally announced as certified, one of the least-known is San Jacinto Petroleum Co. This firm has headquarters in Houston and is owned principally by J. H. Whitney & Co., a New York private investment house. Partners of White, Weld & Co., another New York investment firm, also have a substantial interest. San Jacinto 3 years ago bought royalty interests from E. DeGolyer and now has properties throughout the Southwest and Mid-Continent.

Other companies first listed as certified for participation in the Iranian consortium are Anderson-Prichard Oil Corp., Atlantic Refining Co., Cities Service Co., Hancock Oil Co., Pacific Western Oil Corp., Richfield Oil Corp., Signal Oil & Gas Co., Sinclair Oil Corp., Standard Oil Co. (Ohio), and Tide Water Associated Oil Co.

The twelfth likely participant, now reported to be cleared for membership in the consortium, is American Independent Oil Co., San Francisco. Aminoil holds a half share in the Kuwait-Saudi Arabian Neutral Zone concession.

Gasoline Plant on Steam

The Sultan of Brunei has officially opened a new natural-gasoline plant in the Seria oil field of North Borneo.

The plant of British Malayan Petroleum Co., Ltd. (Royal Dutch-Shell), will have a capacity of about 2,125 bbl. of gasoline daily. The installation covers 5 acres. A 4-in. pipeline has been laid to the Lutong refinery in northern Sarawak, about 40 miles away, where the natural gasoline will be blended into refinery products.

A new topping unit of 700-bbl. daily capacity built at the same time makes Seria field self-sufficient for its gasoline, diesel oil, and private fuel needs. Production at the field is nearly 100,000 bbl. daily, five times its pre-war output.

Shell May Buy Firm

$14-million bid made for English petrochem company

A PIONEERING British petrochemical venture is planning to sell out to Shell.

The company is Petrochemicals, Ltd. Shell Chemical, Ltd., has offered to buy it for $14,000,000 (£5,000,000). Petrochemicals' chairman and managing director, G. L. Outram, has recommended the offer be accepted.

Shortly after the end of World War II, Petrochemicals acquired a license for the Catarole process in the United Kingdom from Petrocarbon, Ltd. A plant using the process to make a line of chemicals, including antifreeze (ethylene glycol) and brake fluid, was brought on stream in February 1949 at Partington, near Manchester.

Outram predicted a competitive fight in the chemical industry, declaring it is essential for a company such as Petrochemicals to tie up with one of the major manufacturers. Big American companies, holding the advantage of owning refineries which assure them of cheap supplies of ethylene, are entering the European market.

Production costs high . . . Petrochemicals needs another $8,400,000 (£3,000,000) to lower production costs and increase its turnover, Outram said. Cost of the Petrochemical operation already is high. The company has a turnover of slightly more than $11,200,000 (£4,000,000) after spending around $33,600,000 (£12,00,000), Outram said. Normally, in the chemical industry, he said, an outlay of one pound should give a turnover of one pound.

The Petrochemical head disclosed that earlier he had negotiated for a tieup with Mathieson Chemical Co., Baltimore, but these discussions ended when Mathieson made other expansion plans.

Most of the capital in Petrochemicals is held by the government's Finance Corp. for Industry which has invested $26,000,000 (£9,500,000). Minority stockholders include the British refining and marketing company, Manchester Oil Refinery, Ltd.

Refinery Located

Greece's first oil plant to be built near Athens

THE Greek Government has decided to build the country's first refinery at Aspropyrgos, 10 miles northwest of Athens.

The construction firm is Hydrocarbon Mineralol, Gm.b.H., Dusseldorf, the German affiliate of Hydrocarbon Research, Inc. It expects to begin work this spring and complete the project by January 1957.

Capacity of the refinery will be 30,000 bbl. daily of crude. The process will include catalytic reforming as well as crude topping, using typical grades of Middle East crude.

The Greek minister of economic coordination stressed there will be no monopoly in procuring raw material or distributing the refinery's output. He indicated if prices of the refinery's products were threatened by dumping, special tariffs would be applied to halt the practice.

Operator of the refinery has not been named. Bids for the construction contract were evaluated with the aid of George Armistead & Co., Washington, consulting engineers, and technical advisors to the Greek government *(The Oil and Gas Journal, February 14, page 93).*

New Platformer Operating

The second Platformer to go into operation in West Germany has been completed at Gelsenberg Benzin, A.G.'s Gelsenkirchen refinery.

The new unit, with a capacity of 7,100 bbl. per day, processes naphtha from Saudi Arabian crude and hydrogenated gasoline. The refinery has a capacity of 39,000 bbl. of crude oil daily, a 10,000-bbl. catalytic cracker, and a 14,000-bbl. hydrogenation unit. Licensed by Universal Oil Products Co., the Platformer was built by Procon, Ltd., and Lurgi Gesellschaft.

OIL DISCOVERED in Italy tests 34° gravity.

IT FLOWED 2,000 bbl. daily through ¾-in. choke.

Second hole planned near . . .

. . . Big Italian Discovery

FOLLOWING up its oil discovery on the Adriatic coast of Italy, Petrosud, S.A., joint Gulf-Montecatini company, this month will start drilling its second well near Pescara.

Petrosud, which has applied for a production concession of 25,000 acres around Cigno 1, will drill Cigno 2 about 1,650 ft. north of the discovery. Cigno 2 is projected to about 4,920 ft. The discovery was 2,550 ft. deep.

The discovery of oil by a private company refueled Italy's heated debate on liberalizing oil laws to create better opportunity for foreign capital *(The Oil and Gas Journal, February 14, page 92)*. Cigno 1 is only a few miles from a dry hole drilled by Azienda Generale Italiani Petroli a few years ago.

The recent discovery along the Adriatic coast flowed about 2,000 bbl. of 34°-gravity oil per day.

Gulf gained its exploration concessions in Italy and Sicily from the J. Elmer Thomas interests. The concessions previously had been offered to and turned down by several large British and United States companies.

DISCOVERY is 16 miles from coast. Offset will be to north.

International Briefs

The Brazilian Government oil monopoly, Petrobras, last week reported discovery of oil in a wildcat in the Amazon River basin 78 miles southeast of Manaus on the Madeira River. Col. Arthur Levy, Petrobras president, said the successful Nova Olinda test represented "the first promising indication of oil in the Amazon basin." Several previous wells in the basin have had negative results.

Shows of gas have been found in southern Spain in a well being drilled about a mile from Ecija in the Guadalquivir Valley by the Spanish Government company, Empresa Nacional Adaro. Further drilling is under way to determine importance of the shows. The well is several hundred miles southwest of the San Lorenzo test being drilled by the joint Spanish-United States group near Cuenca.

Cities Service Co. expects to start its first wildcat in Dhofar in southern Arabia around May 1. Equipment for the test is being moved in. Two wells have been drilled, one between the coast and the mountains, and the other north of the mountains, but these are solely for water supply. Cities Service and Richfield Oil Corp. each has half interest in the venture.

A 5,700-bbl. Platformer has gone on stream at British Petroleum Co., Ltd's., Kwinana, Australia, refinery. It is the second unit to begin operating at the new refinery. The first was a distillation unit which went on stream February 1 *(The Oil and Gas Journal, February 14, page 90)*. A vacuum unit, a catalytic cracker, and a Hydrofiner all are expected to be ready by the end of April. Australasian Petroleum Refinery, Ltd., a B.P. subsidiary, built and will operate the plant.

CATALYSIS
IN PETROLEUM REFINING

24 Catalytic Processes—

Production of today's high-octane fuels would be impossible without the catalytic processes that are being used more and more in petroleum refining. These processes fall into five catagories:

- Catalytic Cracking
- Catalytic Polymerization
- Catalytic Reforming
- Catalytic Alkylation
- Catalytic Hydrogenation

Status of Catalysis—

Here's an article that goes all out on this subject. The author, Dr. Alex G. Oblad, director of research, Houdry Process Corp., briefly reviews the history of catalytic processing refining; tells how catalysts work; and ventures some guesses about the future of catalytic processing. This is the first time this has been done anywhere.

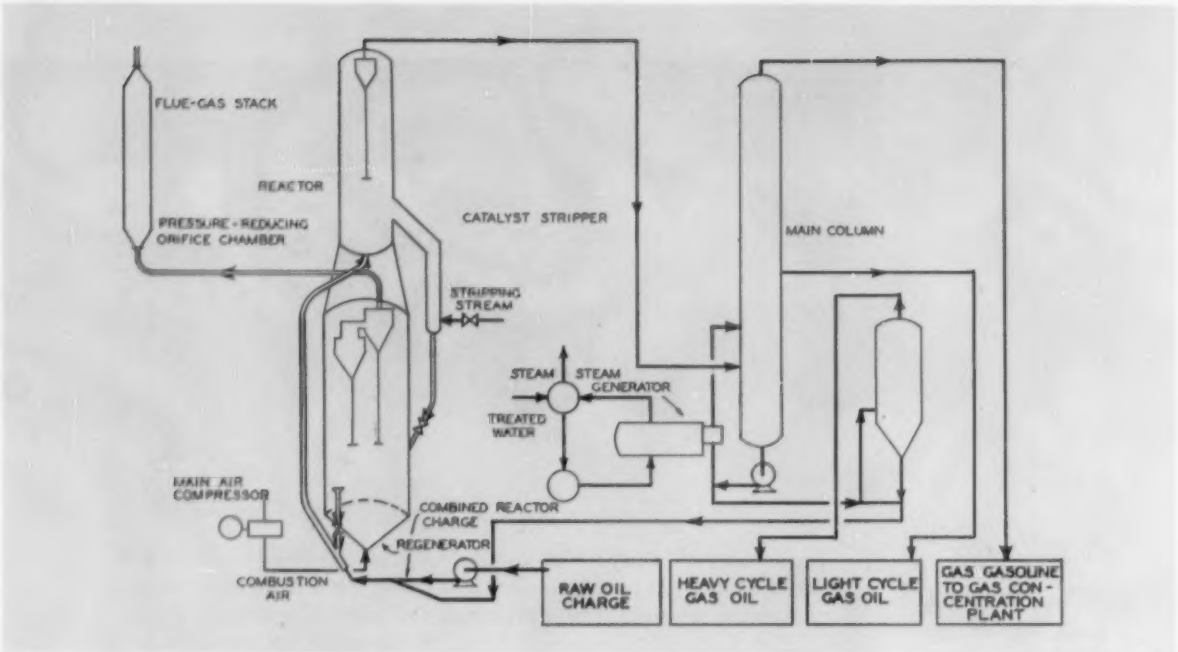
What to expect—

As predicted by research directors and members of management in the companies which have done most to advance refining techniques. Generally, these men look for catalytic process to be used more widely and more intensively in the future.

and—

The Journal's 1955 survey of North American refineries, including the operating plants and construction projects. Also several articles on various subjects encompassing the wide scope of refining interests.

the OIL AND GAS JOURNAL



Fluid Catalytic Cracking

THE U.O.P. fluid catalytic cracking process provides a modern, highly developed technique for producing high-octane gasoline from a large variety of gas oils. The fluid principle is employed to give intimate contact between charge and catalyst on the reactor and optimum regeneration conditions in the regenerator. The energy required for catalyst circulation is furnished by the charge. Current designs are noted for simplicity and ease of operation as well as low operating and investment costs, with optimum product distribution.

Charge . . . An important feature of the process is its ability to crack such a large variety of charge stocks from all types of crude sources. Typical stocks which can be efficiently processed, either virgin or cracked, include naphtha, kerosine, light gas oils, wax distillates, atmospheric and vacuum heavy gas oils, and distillates from viscosity breaking or coking. Feeds high in sulfur or high in nitrogen are successfully processed. In several installations desalted crude is fed directly to the process. In short, boiling range of the charge is not limiting. In U.O.P. catalytic cracking units, the charge is heated to reactor temperature by direct heat exchange with regenerated catalyst making feed preheaters unnecessary. Thus a heavy distillate charge which would rapidly coke up a feed preheater is handled without difficulty.

Description . . . The flow diagram is for a typical 5,000-bbl. per stream day unit.

The gas-oil feed, cold or hot, is charged together with recycle into the hot regenerated catalyst stream, is vaporized, and passes to the reactor where the reaction is completed. The vapors from the reactor, carrying some catalyst, pass upward through the reactor cyclone separator, which removes most of the entrained catalyst, and into the fractionating column.

The spent or used catalyst passes downward from the reactor through the steam stripper and enters the regenerator where the carbon deposit is burned therefrom. Oxygen for combustion is supplied by air from the air blower. The flue gases carrying some catalyst pass upward through the regenerator cyclone separators where entrained catalyst is removed and pressure is released in a pressure reducing chamber which serves as a noise eliminator. The regenerated catalyst again enters the incoming gas-oil charge stream to repeat the cycle.

For a typical unit of this capacity the "single vessel" type (reactor superimposed upon the regenerator) is used.

Heat-balance unit . . . This unit is of the "heat-balance" type wherein the heat of combustion in the regenerator is used to preheat the feed to reactor temperature. This arrangement provides several important process advantages: (1) the liquid charge, on contact with hot regenerated catalyst, vaporizes and lifts the catalyst into the reactor; (2) since no preheat is given the feed, it is unnecessary to provide equipment for cooling catalyst; (3) by elimination of fresh feed and regenerated catalyst heat exchangers, plant investment is correspondingly reduced and maintenance is simplified.

The initial heat to bring the unit on stream is supplied by a direct-fired air heater and torch oil in the regenerator.

The fractionating column is, in general, conventional, with gasoline taken overhead and one or more se-

lected fractions withdrawn as side cuts. The net column bottoms are sent to storage via the slurry settler. Steam may be generated by recovery of heat in the fractionator column bottoms. Catalyst-containing oil from the bottom of the slurry settler is returned to the reactor with the fresh feed and may amount to from 2 to 10 per cent of the fresh feed.

The unstabilized gasoline and gas from the low-pressure receiver pass to the gas fractionation section for debutanization and recovery of C_3-C_4 polymerization unit feed.

The fresh-feed capacity of a catalytic cracker, in general, depends upon the conversion, combined feed ratio, and the coke-burning capacity of the regenerator.

The total catalyst inventory of a 5,000-bbl. per stream day unit, burning around 4,200 lb. per hour of coke, at 53 per cent conversion, is about 37 long tons.

The U.O.P. regenerator design is set up for optimum pressure to increase the coke burning rate (pounds of coke burned per hour per pound of catalyst inventory in the regenerator) and the regenerator is therefore reduced in size, which reduction in turn reduces the catalyst inventory in the unit. Thus catalyst replacement rate expressed in pounds per barrel required to maintain a given catalyst activity is low.

With the proper velocity in the regenerator, a small catalyst inventory, and two-stage cyclone separators of the proper design, the catalyst loss at 53 per cent conversion will not exceed 0.25 lb. per barrel of fresh feed and for 70 per cent conversion will not exceed 0.40 lb. per barrel. This catalyst loss is normally such as to maintain the catalyst activity.

Yields . . . Typical yields from a U.O.P. fluid catalytic cracking unit when cracking a 31° A.P.I. Mid-Continent gas oil, over silica-alumina catalyst, in once-through and recycle operations, are shown in Table 1.

TABLE 1—TYPICAL YIELDS

Operation—	Once-through	Recycle
Conversion	60	75
Yields (volume per cent):		
Debutanized gasoline	45.0	53.0
Cycle stocks	40.0	25.0
Butylenes	5.8	7.1
Butanes	8.7	9.4
Propylene	5.2	6.4
Propane	2.4	3.3
C_2 and lighter gas, weight per cent	2.5	3.1
Octanes, 10-lb. R.v.p. gasoline:		
Motor method (F-2) clear	81.8	81.8
+ 3 cc. TEL	86.8	87.4
Research method (F-1) clear	93.7	94.2
+ 3 cc. TEL	98.7	99.1
Yields with polymerization (volume per cent):		
10-lb. R.v.p. polymer gasoline	8.0	9.9
10-lb. R.v.p. catalytic gasoline	47.4	55.8
Total 10-lb. R.v.p. gasoline	55.4	65.7

Commercial installations . . . At the present time there are nearly 60 U.O.P. fluid catalytic cracking units in operation or under construction. These represent a total design feed capacity of over 400,000 bbl. per day, and sizes ranging from 1,400 to approximately 35,000 bbl. fresh charge per day.

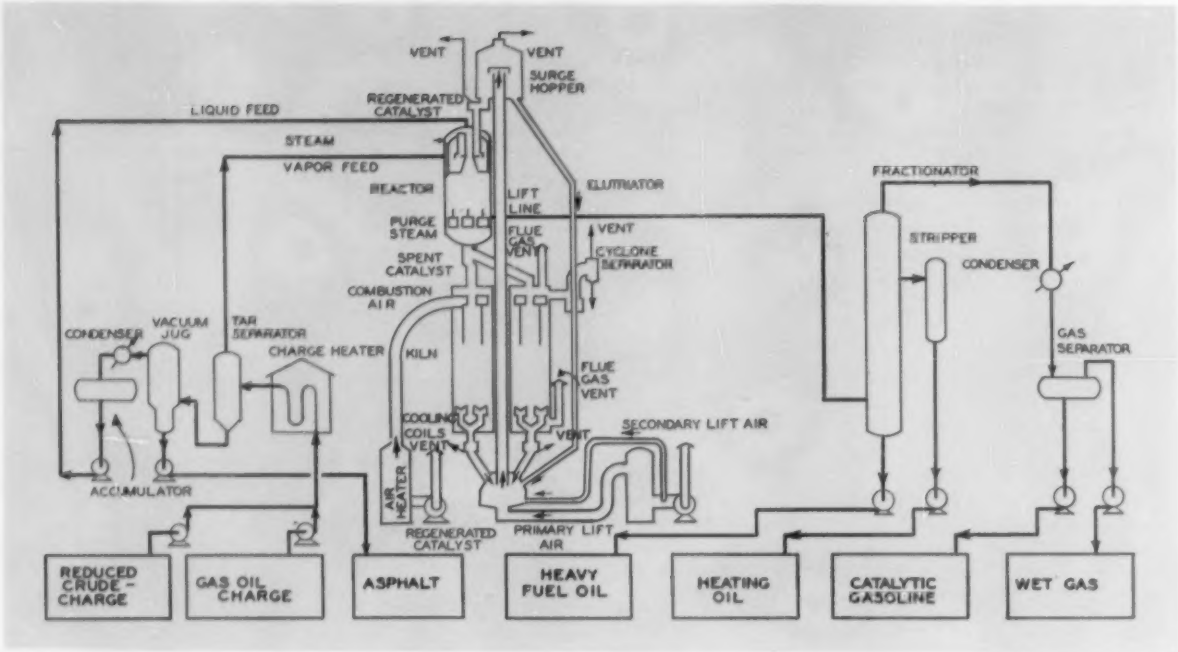
Additional data are presented in Tables 2 and 3. These are design data for recent units, using silica-alumina catalyst.

TABLE 2—YIELDS, OKLAHOMA GAS-OIL CHARGE

Conversion, weight per cent gas oil disappearance	70
Yields (volume per cent):	
Debutanized gasoline	50.5
Light cycle oil	25.0
Heavy cycle oil	5.0
Butylenes	6.0
Isobutane	5.2
n-Butane	1.7
Propane-propylene and ethane-ethylene (total, per cent by weight)	7.8
Combined feed ratio, by volume	1.66
Catalyst-to-oil ratio:	
On raw oil	19.1
On combined feed	11.3
Weight hourly space velocity:	
On raw oil	6.2
On combined feed	9.5

TABLE 3—YIELDS, RECENT UNIT

Conversion	74.0
Yields, volume per cent:	
Debutanized gasoline	51.5
Light cycle oil	21.0
Heavy cycle oil	5.0
Butylenes	6.8
Isobutane	6.6
n-Butane	2.4
Propane-propylene, weight per cent	6.41
Ethane and lighter, weight per cent	3.19
Combined feed ratio, by volume	1.63
Catalyst-to-oil ratio:	
On raw oil	18.3
On combined feed	11.0
Weight hourly space velocity:	
On raw oil	5.8
On combined feed	9.75



Thermofor Catalytic Cracking

THE Thermofor catalytic cracking (T.C.C.) process was commercialized in 1943 at Beaumont, Tex. Socony-Vacuum's Airlift T.C.C. design was discussed in early 1950 *(The Oil and Gas Journal, May 11, 1950)* and the first commercial unit of this Airlift design started operation in October 1950, also at the Beaumont Refinery of Magnolia Petroleum Company *(described in the June 28, 1951, issue of The Oil and Gas Journal)*. At the end of 1954, 36 Airlift T.C.C. units were in operation, and 11 more under construction.

Upon completion of these units the aggregate charge capacity of the Socony Airlift T.C.C. design will be over 600,000 bbl. per day. The individual units cover a wide range of capacities, with design feed rates between 1,600 and 28,000 bbl. per day, and design carbon-burning capacities between 1,100 and 15,000 lb. per hour. Another Socony Airlift T.C.C. single unit now planned and in the engineering stage will have a carbon-burning capacity of 29,000 lb. per hour.

Moving-bed principle . . . The Airlift T.C.C. unit and its predecessor, the bucket-elevator type T.C.C. unit, both employ the moving-bed principle invented and developed by the research and development and the engineering organizations of Socony-Vacuum Oil Co. and are licensed to the industry under patents of Socony. In the moving-bed designs, the catalyst flows by gravity in a compact mass from surge hoppers at the top of the units through the reactor and regenerator to the low point in the systems where the flow is controlled and where it discharges into suitable equipment for elevating it to surge hoppers to complete the cycle.

As the names indicate, the bucket-elevator T.C.C. unit employs mechanical elevators to circulate the catalyst while the Airlift T.C.C. unit uses a pneumatic lift for such purposes.

All the advantages of the T.C.C. moving-bed system are inherent in both the bucket-elevator and the Airlift T.C.C. units, such as:

1. High liquid recovery.
2. High cracking efficiency.
3. High equilibrium catalyst activity.
4. Superior contacting of catalyst and reactants.
5. Ease of operation because of relatively high catalyst inventory in system acting as a "flywheel."
6. High gasoline-to-coke ratio.

Fig. 1 is a simplified flow sheet of the unit. The main parts of the catalytic system are the reactor, the kiln, and the airlift. Air for lifting is supplied by a low-pressure centrifugal blower to the lift pot at the bottom of the system in the form of primary and secondary lift air.

Eliminates need of control valves . . . This arrangement eliminates the need for catalyst control valves at any point in the system. The lift pipe is designed with taper so that proper velocities can be maintained throughout the entire length. In the surge hopper the catalyst is disengaged from the air and the catalyst operating level is maintained. Commercial lifts have been designed for rates of up to 500 tons per day, although they are not limited to this capacity.

With the latest improvements, basic attrition rates of less than 0.5 tons per day per 100 tons per hour circulation have been attained on bead catalyst. This is equivalent to about 0.2 lb. of catalyst per barrel of charge at the operating conditions usually employed.

One of the important features of T.C.C. moving-bed systems involves having the catalyst flow from the surge hopper at atmospheric pressure into the top of the reactor at 15 psig. maximum through a seal leg. Steam

introduced at the base of this leg flows countercurrent to the catalyst and prevents the escape of vapors to the hopper. The seal leg is tapered for uniform pressure drop and its length determines the maximum operating pressure.

Operating pressure . . . Actual operating pressure depends on pressure drop through the reactor and the recovery system. With the gas accumulator at 0 psig. the reactor outlet will be on the order of 6 psig. and the top of the reactor will be 9-13 psig. Fig. 1 indicates the reactor arrangement for a combined vapor and liquid feed unit wherein a part of the catalyst flows through pipes around the wall of the vessel and serves to maintain a fixed bed level while the main stream of catalyst flows as a falling curtain in the center. The liquid feed enters through a nozzle and sprays on the catalyst surface within the falling curtain of catalyst while the vapor enters above the catalyst and passes down through it.

For a vapor-feed reactor the liquid feed nozzle and catalyst curtain system are omitted and the catalyst is uniformly distributed over the reactor area. All vapor feed reactors may be easily converted to liquid feed operation and liquid feed reactors may be operated on vapor alone. Oil vapors and catalyst pass concurrently through the reactor where excellent contact of oil vapors and catalyst is maintained at all points by virtue of the moving-bed system.

In the bottom the vapors are disengaged by a series of disengaging channels into a plenum chamber where they leave the reactor. The catalyst is purged with steam which flows countercurrent to catalyst into the reactor effluent stream. This countercurrent stripping is designed to give substantially complete removal of hydrocarbon from the spent catalyst.

Successful commercial operation has also been conducted on a reactor designed to charge a heavy gas oil fed as one stream, thus eliminating the usual tar separator. This reactor design is especially applicable where the refiner has a heavy-gas-oil feed stock already available.

Circular design . . . The T.C.C. Airlift kiln is circular in design, and, as indicated in Fig. 1, has a hole in the center through which the lift pipe passes, except in the smaller kiln sizes. Spent catalyst enters through several pipes and is distributed uniformly over the kiln area. Combustion air at about 2 psig. is introduced through a header box at the top of the kiln down through pipes subtended from the box and out into the center of the bed.

Part of the air passes up countercurrent to the catalyst flow and out the top flue gas stack. The quantity of this air is controlled by a back pressure regulator in the upper stack. The remainder of the air passes down with the catalyst through a disengaging channel and out of the system through the lower stack.

The maximum temperature in the kiln is limited to 1,350° F. to avoid damage to the catalyst and to the kiln internals. Heat is removed from the catalyst by coolers. Below the kiln the catalyst flows through a metering box which is at atmospheric pressure and then into a short seal leg which feeds the lift pot on the same principle as the seal leg which feeds catalyst to the reactor.

Higher burning temperature . . . The original units exceeded design charge throughput shortly after going on stream. Catalyst circulation and carbon burnoff in excess of design have also been attained. More recently, small improvements in kiln internals have reduced temperature variations so that a higher average burning temperature is possible while maintaining the same limit on maximum temperature. As a result, by making minor additions to the kiln and taking advantage of reactor throughput and catalyst circulating capacity already available, existing units may be operated at approximately 30 per cent above design. Similarly, the investment for any new installation will be reduced by taking advantage of these same factors.

Both synthetic bead catalyst and natural clay catalyst are being used, with the former more generally accepted. Synthetic bead catalyst was developed and is supplied by Socony-Vacuum. This material is also manufactured and marketed by Kali-Chemie A.G., of Germany, under license from Socony. The bead catalyst is silica-alumina to which a small percentage of chromic oxide has been added to improve regeneration characteristics. It is manufactured in the form of small spheres with a particle-size range of 4 to 8 mesh. Activity index of fresh catalyst is 34 by the CAT-A method and this reaches an equilibrium value of 28-30 in the unit.

The unit is designed to charge a wide range of stocks from any type of crude. In many cases the charge to catalytic cracking is the fraction above kerosine to asphalt although the units have been designed and operate equally well on heavier gas oils as well as wider fractions which contain heavy naphtha. In this latter operation, an octane lift of as high as 15-20 units on the naphtha fraction has been realized. Also, good cracking results are obtained on the kerosine fraction when included in the feed.

Other charge stocks include whole crude above asphalt, coker, and visbreaker gas oils or full-range distillates, solvent deasphalted raffinates, and extracts from solvent lube operations. Heavy gas oil above heating oil or full-range gas oil above gasoline may be recycled in whatever ratio refinery economics indicate is desirable.

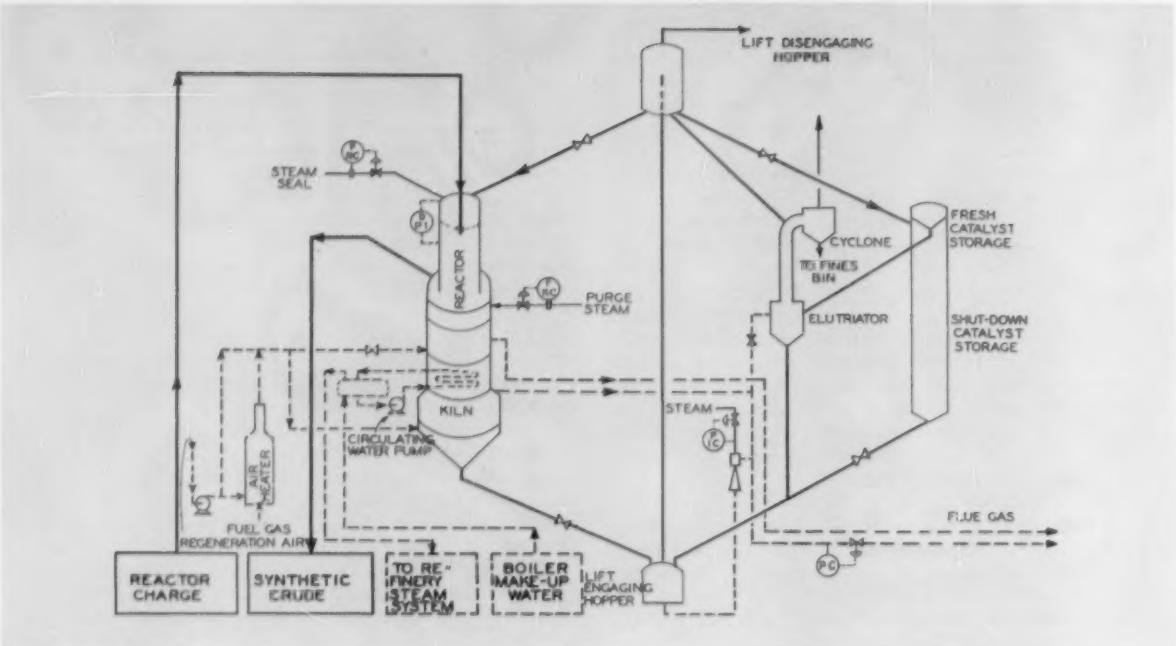
Commercial data on T.C.C. processing heavy gas oils from Middle East and Venezuela crudes are shown below:

Conversion, per cent volume	54.3
Ethane and lighter gas, per cent weight	3.5
Propanes, per cent volume	6.3
Butanes, per cent volume	7.5
Gasoline (10 psi., R.v.p.) per cent volume	43.3
Light cycle stock, per cent volume	27.1
Heavy cycle stock, per cent volume	18.6
Coke, per cent weight	5.8
Total liquid recovery, per cent volume	102.8
C_3 free liquid recovery, per cent volume	96.5

PROPERTIES

Stream—	Fresh feed	Gasoline	Light cycle	Heavy cycle
°A.P.I.	27.3	60.5	27.0	18.4
10 per cent	670	115	482	648
50 per cent	872	208	524	...
95 per cent	995	360	595	...
Research octane + 3 cc. TEL	...	96.6	...	...
R.v.p., psi.	...	10	...	...

This process is licensed by Socony-Vacuum Oil Co.



Houdriflow Catalytic Cracking

HOUDRIFLOW is an efficient continuous moving-bed catalytic cracking process by which high yields of top-quality gasoline and other products are obtained from a wide variety of charge stocks.

The modern Houdriflow unit integrates the catalytic reactor and the regenerating kiln in a single vessel, recirculating the regenerated catalyst to the reactor by a pneumatic lift system. Synthetic or natural catalysts may be used.

The process is distinguished for ease of operation under normal and emergency operating conditions, low maintenance and operating cost, high catalyst activity in conjunction with low catalyst makeup cost, and flexibility as to charge stocks handled and conversion levels attained.

Installations . . . The 15 commercial Houdriflow units now in operation have a nominal design charge capacity of 153,830 bbl. per day. The five Houdriflow units now licensed or in construction have a design charge capacity totaling 98,000 bbl. per day.

Motor gasolines with octane values in the 88-94 F-1 clear range, and 95-99 F-1 with 3 cc. TEL, are produced by Houdriflow units, depending upon the temperature, charge stock, and catalyst in the individual installation.

The reactor feed may be all liquid, all vapor, or a mixture of both. With the exception of one unit, the charge to all commercial Houdriflow units is over 50 per cent liquid, and in some cases the charge is totally liquid phase.

A wide variety of petroleum distillate stocks are being catalytically cracked in Houdriflow operations. Sweet and sour stocks are handled with equal ease, as well as any fraction from the crude boiling between naphtha and penetration asphalt.

Conversion above 90 per cent has been achieved with relatively low coke deposits in some units, using recycle ratios of 1 to 1 or slightly more. In cases where once-through cracking is preferred, 50 to 60 per cent conversion is obtained. The total reactor feed, in some instances, has been accumulated cycle stock.

Improvements in design . . . Continuing field and laboratory research has led to a number of improvements in the Houdriflow process. The height of the unit has been decreased by improving the design of the seal between the reactor and kiln.

All problems of pressure balance between the reactor and kiln have been eliminated. An improved lift arrangement permits the kiln to function at pressures of less than 5 psig., with only a single stage blower required for regeneration air.

Steam jet compressors compress flue gas from the kiln and deliver motive gas at a constant rate to the lift system.

The reactor may be bypassed, if necessary, without disturbing the operation of the kiln and lift systems.

Uniform catalyst flow through the reactor and kiln for obtaining maximum efficiency is assured by the new catalyst drawoff system now embodied in Houdriflow operations.

Improving cooling-coil design reduces cost by eliminating outside header boxes. Simplifications in equipment have further reduced the previously low cost of alloy protection needed in processing high-sulfur stocks.

Process summary . . . A typical Houdriflow unit's major components may be arranged in a compact manner on

"Sweet and sour stocks are handled with equal ease"

a ground area approximately 40 by 60 ft. The reactor-kiln and hot catalyst storage vessels are self-supporting, and generally are located on opposite sides of a steel structure housing a stairway and supporting the catalyst lift and elutriator.

Charging stocks—vapor, liquid or mixture—flow into the reactor through a specially designed nozzle. Cracked vapors are separated from the catalyst in a disengager and sent to the synthetic crude tower. A countercurrent flow of low-pressure steam purges residual oil from the catalyst.

The purged hydrocarbons join the main stream of cracked vapors and flow on to the synthetic crude tower.

Catalyst movement . . . Catalyst flows by gravity from the lift disengager. About 75 per cent of the catalyst enters the reactor through a central pipe and is admitted to the cracking zone through an annular opening surrounding the charge-stock nozzle.

The remainder of the catalyst reaches the cracking zone through a circle of pipes located near the vessel's periphery. These pipes maintain the top of the catalyst bed at the desired level, in effect setting the space velocity.

Catalyst flows downward from reactor to purge, and through the intermediate seal section, entering the kiln where the coke deposit is removed by combustion with countercurrent air. Transverse cooling coils extract excess heat of regeneration from the catalyst, and this is recovered as steam.

From the kiln, catalyst flows down through an improved collecting device into a single line and on to the lift engager. A mixture of flue gas and steam from the thermocompressor lifts the catalyst to the top of the unit, and the movement cycle is complete.

Another part of the flue gas is used for elutriation and the remainder, together with upper zone flue gas, is discharged to the stack. Steam produced in cooling the catalyst is normally used for operating the air blower, pumps, and thermocompressors. Low-pressure exhaust steam from pumps serves requirements for catalyst purging, sealing, etc.

A small percentage of the catalyst circulation is continuously fed from the bottom of the lift disengaging hopper to the elutriator for stripping by countercurrent flue gas, to control particle size of the catalyst.

Major process variables are temperature, catalyst-to-oil ratio, and space velocity. Regulation of these variables, along with extent of recycling, allows wide flexibility in the Houdriflow process with respect to product distribution and quality required. Normal operating conditions fall within these ranges:

Temperature, °F.	850-925
Pressure, psig.	9-10
Space velocity, v./hr./v.	1.5-4
Catalyst/oil ratio	3-7

Performance data . . . In the table, percentages of Houdriflow conversion products are shown for operation with three widely different charge stocks. Note in Column C the highest percentage of gasoline yield ever achieved by a cat cracker.

This process is licensed by Houdry Process Corp.

TABLE I—TYPICAL HOUDRIFLOW YIELDS WITH FEEDS OF VARIED COMPOSITION

Charge:*	A	B	C
Virgin gas oil	5,810	4,460	4,750
First pass cat. gas oil	1,430	.....	.....
Recycle	.....	2,200	5,700
Total charge, bbl. per day	7,240	6,660	10,450
Products:			
Gasoline, 10 lb., 380/90, volume per cent	40.8	53.7	67.8
Total gas oil, volume per cent	50.3	31.1	9.2
C_3-C_4 recovered, volume per cent	16.1	18.6	25.0
Liquid recovery, volume per cent	107.2	103.4	102.0
Fuel gas, weight per cent	3.8	5.8	7.3
Catalyst deposit, weight per cent	5.2	5.4	9.0
Gasoline octanes:			
F-1 Clear	91.5	90.6	89.3
F-1 + 3 cc. TEL	.....	.....	96.7
F-2 Clear	81.7	.....	.....

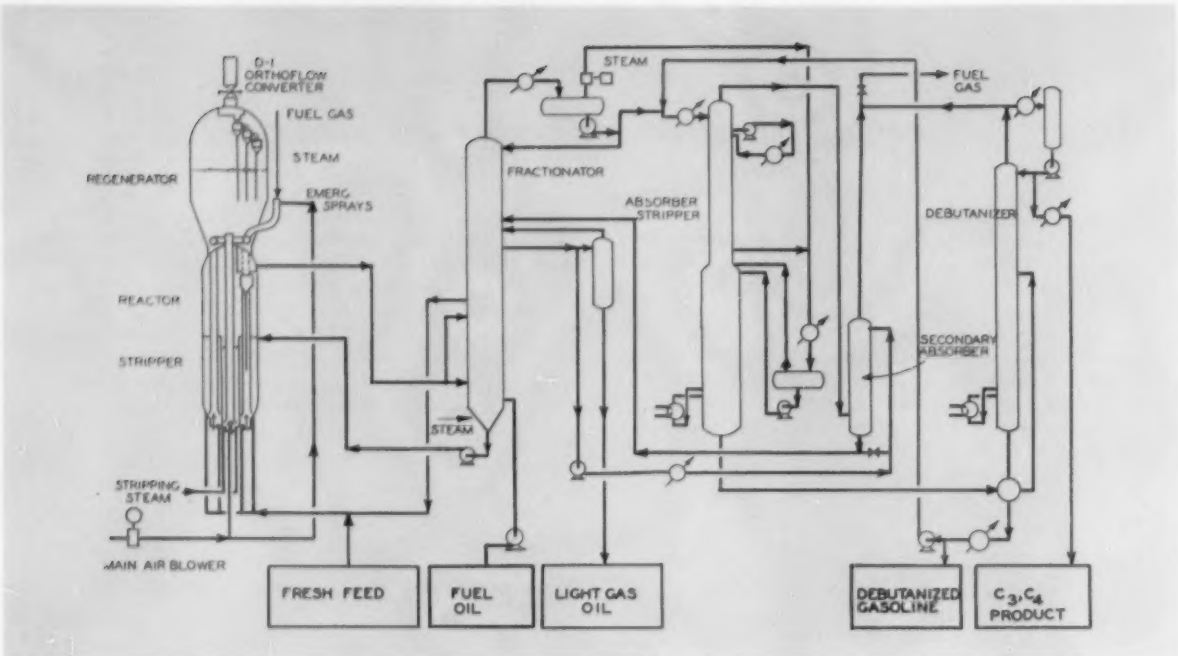
*Charge stocks are atmospheric plus vacuum gas oils from: (A) Texas pipeline crude, (B) Scurry crude, and (C) Hutchinson-Moore County, West Texas, crude.

UNITS IN OPERATION

	Capacity, bbl./day
Tide Water Associated Oil Co., Drumright, Okla.	6,750
Sun Oil Co., Toledo	30,000
Clark Refining Corp., Blue Island, Ill.	5,000
Salt Lake Refining Co., Salt Lake City	13,000
California Oil Co., Barber, N. J.	25,000
Shamrock Oil & Gas Corp., Sunray, Tex.	11,000
Standard Oil Co. of Texas, El Paso, Tex.	11,500
Texas City Refining Co., Texas City, Tex.	18,730
Gewerkschaft Erdoel-Raffineries Emsland, Lingen, Germany	17,500
Sun Oil Co., Sarnia, Ont.	11,500
Albatros S. A. Belge pour le Raffinage de Petrole, Antwerp, Belgium	3,650

UNITS UNDER CONSTRUCTION

	Capacity, bbl./day
Daikyo Oil Co., Yokkaichi, Japan	4,200
Canadian Petrofina, Ltd., Montreal, Canada	16,000
Sun Oil Co., Marcus Hook, Pa.	27,000
Sun Oil Co., Toledo	24,000
Commonwealth Oil & Refining Co., Puerto Rico	26,800
Total number of units in operation or under construction	20
Total nominal capacity of these units, bbl. per stream day	251,830



Orthoflow Catalytic Cracking

STRAIGHT-LINE fluid catalytic cracking, in which reactor and regenerator are combined in a single vertical structure, was developed for the production of high-octane gasoline at low investment cost.

This Orthoflow design, developed and licensed by M. W. Kellogg Co., provides straight-line flow of catalyst between the vessels, thereby reducing catalytic erosion.

Two modifications of the design have been developed and proved in commercial installations: Model A with the reactor positioned atop the regenerator, which is operated at about 8 psig. above reactor pressure to afford proper balance; and Model B, in which the positions of reactor and regenerator are reversed.

Model B . . . In the improved Model B design, the pressure differential between reactor and regenerator is reversed, considerably reducing utilities requirements and operating costs. In effect, this design raises the suction pressure of the compressor handling reactor gas, and lowers the discharge pressure of the blower furnishing combustion air to the regenerator. The sizes of the reactor and fractionator are also reduced in this design.

At present 13 units of the Orthoflow design are operating or under construction—6 Model A units with a total throughput capacity of 46,500 bbl. per day, and 7 Model B units with a capacity of 230,000 bbl. per day.

Operating features . . . The accompanying diagram illustrates the schematic flow of a typical Model B Orthoflow catalytic cracker. Preheated fresh feed combines with recycle gas oil from the fractionator and flows to the Orthoflow converter.

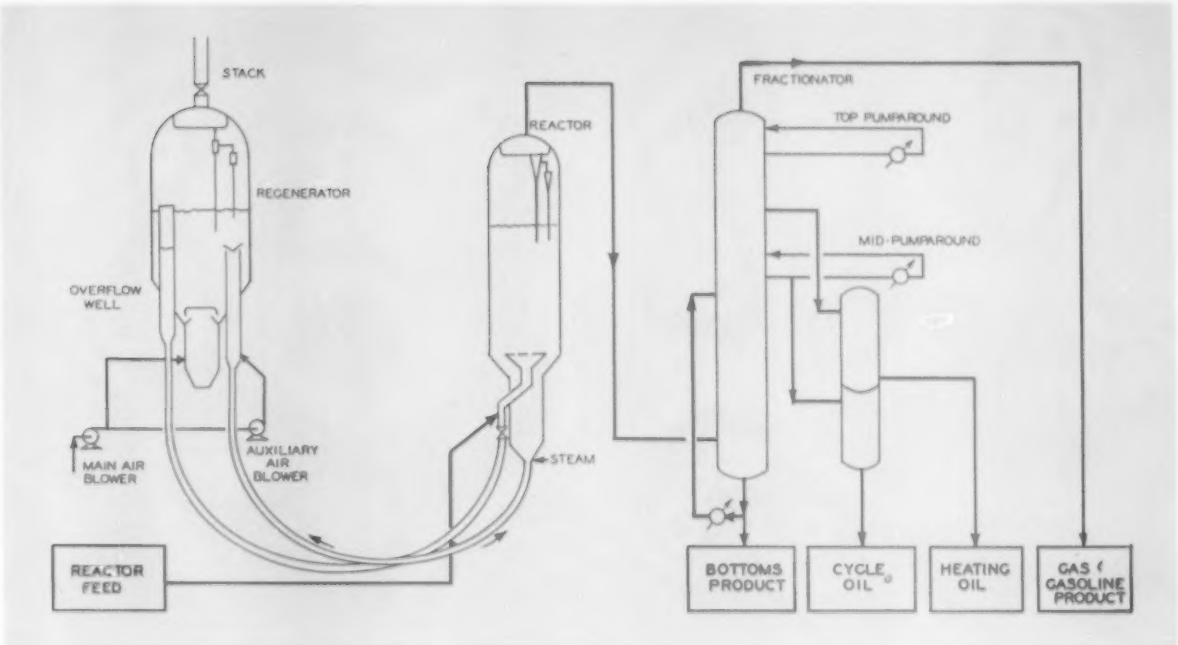
Catalyst and oil vapors are delivered to the bottom of the reaction section. The fluidized catalyst bed depth is controlled at a level providing sufficient contact time of catalyst with oil vapor to obtain desired conversion. Above the fluidized bed, a disengaging space is provided for separation of the powdered catalyst from the cracked vapors. The vapors then pass out of the reactor through single-stage cyclones where any catalyst carried through the disengaging space is recovered and returned to the reactor bed.

Spent catalyst is withdrawn from the reactor bed and fed to the stripper through openings in the partition. Steam and stripped vapors are vented through the open top of the stripper section into the disengaging space above the reactor bed.

Stripped spent catalyst flows from the bottom of the stripper through a plug valve, and air is introduced through the hollow stem of the plug valve to convey the catalyst upward into the regenerator. The spent-catalyst plug valve provides direct control of the level of the catalyst bed in the reactor-stripper section.

TYPICAL YIELDS FROM MODEL B ORTHOFLOW CAT CRACKER

Fresh feed, mixed gas oil, bbl. per day	17,600
Gravity, °A.P.I.	28.0
Throughput ratio	1.5
Conversion, volume per cent	70.8
Tail gas, weight per cent	7.8
C_3 to poly, weight per cent	6.9
C_4+ gasoline, volume per cent	58.0
Light cycle oil (No. 2 fuel), volume per cent	23.5
Debutanized gasoline:	
Gravity, °A.P.I.	58.0
R.v.p., psi.	7.0
50 per cent point, °F.	210
End point, °F.	420
C.F.R.-R. Clear	92.0



Model IV Catalytic Cracking

FLUID catalytic cracking accounts for 70 per cent of the total installed catalytic cracking capacity in the United States. It accounts for 78 per cent abroad.

A continuous process, fluid cat cracking gives excellent yields of high-octane gasoline. It also gives excellent yields of important byproducts such as isobutane and light olefins for alkylation, polymerization, L.P.G., or synthetic rubber. Its inherent flexibility enables the refiner to meet changing market demands.

Improvements . . . Improved features have resulted in substantially lower investment and operating costs. Improvements include: simpler, more compact design; simplified catalyst recovery; more compact catalyst circulation systems; smaller vessels sizes; and improved mechanical and plant layout features. The Model IV requires only one-third of the steel used in original designs.

Catalyst flow . . . The process is based on the circulation of finely divided catalyst suspended in gas or vapor. Flowing much like a liquid, the catalyst circulates continuously between the reactor and regenerator. Oil is fed continuously to the reactor where cracking occurs. The catalyst becomes fouled with carbon during the reaction. In the regenerator, the hot catalyst is contacted with air which burns off the carbon. By flowing continuously, the catalyst acts as a heat-transfer medium between the regenerator where heat is liberated and the reactor where heat is absorbed by the reaction. Temperature is controlled by the regulation of catalyst rate.

Feed is injected into the hot regenerated catalyst line just before it enters the reactor.

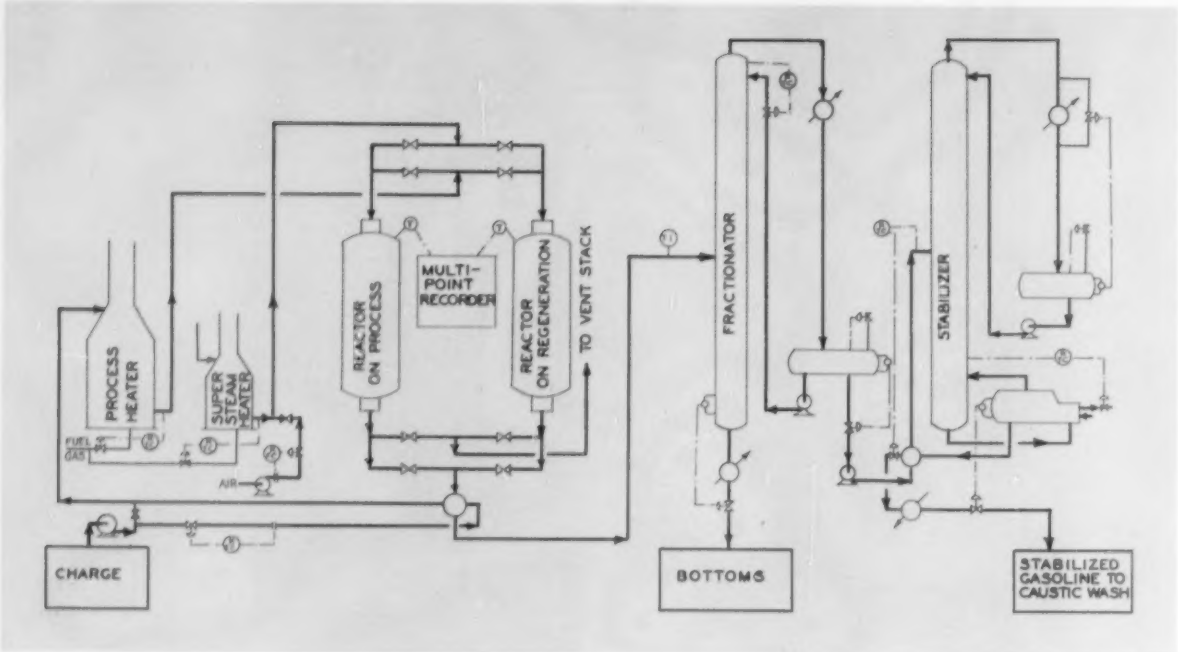
Products . . . Products are removed in vapor form through cyclone separators which return most entrained catalyst to the bed. Cracked products are then separated in conventional fractionation and absorption equipment.

The largest Model IV unit was recently licensed to Standard Oil Co. of California and installed at the El Segundo refinery. It is designed to operate at 40,000 bbl. per day of high-coke-forming fresh feed, circulates 60-75 tons per minute of catalyst and has the largest known coke-burning capacity of any cat cracking unit yet built. Catalyst loss is less than 40 lb. per hour.

Typical yields from Model IV fluid catalytic cracking, recycle operation, would be as follows:

	23.3° A.P.I. Columbian gas oil	32.8° A.P.I. paraffinic Sumatra gas oil
Conversion, volume per cent fresh feed	78.8	72.0
Yields:		
Debutanized gasoline, vol. % F.F.	58.9	53.7
Light cycle gas oil, vol. % F.F.	18.2	25.2
Heavy cycle gas oil, vol. % F.F.	3.0	2.8
Butylenes, vol. % F.F.	9.6	10.5
Butanes, vol. % F.F.	7.4	8.4
Propylene, vol. % F.F.	8.5	6.8
Propane, vol. % F.F.	3.1	2.6
C_2 and lighter gas, wt. % F.F.	3.7	2.8
Coke, wt. % F.F.	8.6	4.8
Inspections:		
Fresh feed:		
20% at °F.	675	700
50% at °F.	835	795
80% at °F.	990	900
Debutanized cat gasoline:		
C.F.R.R. clear	94.4	92.5
R.v.p.	6.4	5.8
With polymerization:		
Yield, total 10-lb. R.v.p. gasoline, vol. % F.F.	75.4	70.1
C.F.R.R. clear, 10-lb. R.v.p. gasoline, vol. % F.F.	95.9	94.4

The Model IV catalytic cracking process is licensed by Esso Research & Engineering Co., New York.



Cycloversion

THE Cycloversion process is applied to three types of operation for upgrading refinery stocks to increase the yield of high-octane gasoline. These applications include the following:

. . . **1. Desulfurizing gasoline stocks,** both straightrun and cracked gasoline, naphtha fractions, and kerosine—in this application, Cycloversion has proved to be a valuable feed-preparation unit for desulfurizing feed to those reforming processes which employ platinum catalyst. Where sulfur content of the charge to such reforming processes is so high as to require pretreatment in order to avoid platinum catalyst poisoning, the Cycloversion process effectively lowers the sulfur content so that a suitable charge stock is obtained.

. . . **2. Reforming straightrun gasoline** or naphtha to upgrade octane numbers and improve lead susceptibility—this operation accomplishes desulfurization, cracking and molecular rearrangement.

. . . **3. Catalytically cracking** gas-oil stocks to produce high-octane gasoline—in this type of operation, gas-oil stocks having end points up to 800°-850° F. are easily processed to give good yields of high-octane gasoline, an excellent middle distillate suitable for diesel fuel, and a bottoms product which can be blended off with heavy fuel oil or thermally cracked for further processing.

Additionally, Cycloversion has been applied to the treatment of highly olefinic synthetic gasoline. Cycloversion treatment isomerizes such stocks by causing the double bond to shift from the end towards the center of the molecule.

The accompanying flow diagram shows the basic equipment included in a Cycloversion unit. With the exception of the reactors, all equipment is of conventional design. The reactors are designed for downflow operation and to permit regeneration of the catalyst in place. All equipment shown in the flow diagram is required for reforming or gas-oil cracking operations, in which operations the carbon position rate is appreciably higher than in desulfurization. Therefore, as shown in the flow diagrams, it is necessary to incorporate the steam superheater and air compressor in order to regenerate the catalyst.

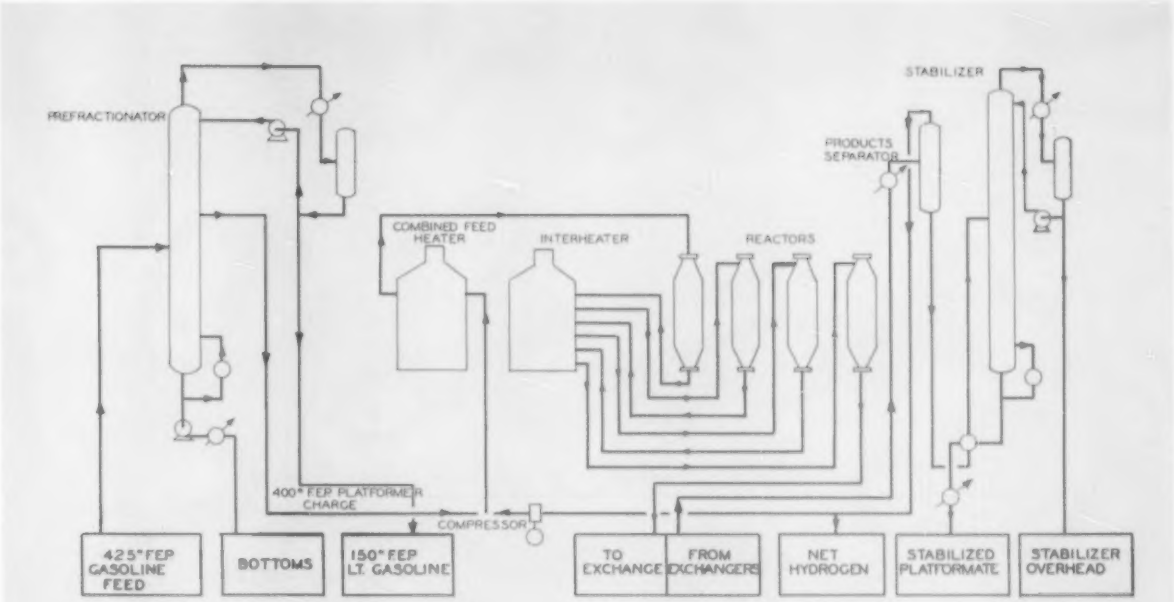
For desulfurization operations the fractionation and stabilization facilities may or may not be required. They are not normally used for this type of operation since desulfurization effects no appreciable change in the composition of the feed stock other than the reduction of its sulfur content.

Same catalyst used . . . The same catalyst is employed for all the operations herein mentioned. It is Cyclocel grade bauxite and is a naturally occurring material. Catalyst life of 5,000 to 20,000 bbl. (feed stock processed) per ton of catalyst is generally obtained in nonregenerative desulfurization units. For units employing regeneration, the catalyst life is a function of the regeneration frequency. Generally, a throughput of 50,000 to 100,000 bbl. per ton is expected in reforming.

The major process variables are temperature, pressure, and space velocity. Conversion depth is increased by high temperatures. Olefinicity of the product gasoline is increased by low operating pressures. An increase in space velocity at constant temperature decreases the depth of conversion.

The yields from desulfurization vary from 98 to 99½ liquid volume per cent of the charge. Reforming yields are dependent on the severity of the operation. This is also true for gas-oil cracking, although gas-oil operations are normally conducted to achieve a 50 per cent conversion level.

This process is licensed by Phillips Petroleum Co.



Platforming

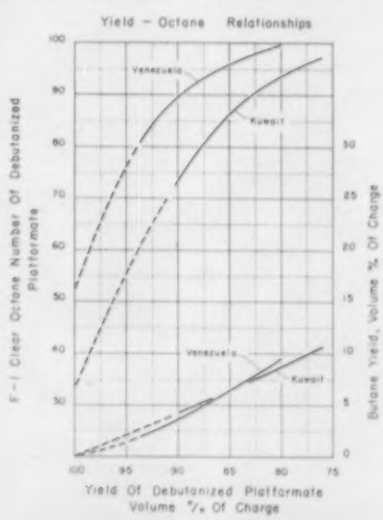
THE U.O.P. Platforming process is the pioneer catalytic reforming process employing a platinum-containing catalyst. It will produce high-octane-number motor fuel or aviation-gasoline components from low-octane naphthas, or alternatively will produce aromatic concentrates for aromatic extraction from select naphtha cuts.

Following the first commercial demonstration in a Michigan refinery in 1949, the process has been widely used for improving naphthas ranging from the highly paraffinic stocks of the Middle East and Pennsylvania to the highly cyclic stocks of Venezuela and California.

Reactions . . . The catalyst promotes a number of reactions, including:

1. Production of aromatics from naphthenes and from long chain paraffins.
2. Isomerization of paraffins and naphthenes.
3. Hydrocracking of paraffins.
4. Conversion of organic sulfur compounds to H_2S.

In motor-fuel production, all these reactions are important, and operating conditions are chosen so that a suitable balance is obtained between hydrocracking, which increases volatility of the product and aromatization, which decreases volatility. In manufacture of aromatic concentrates, conditions are selected to result in minimum hydrocracking and maximum aromatization.



Yield-octane relationships in Platforming two different stocks.

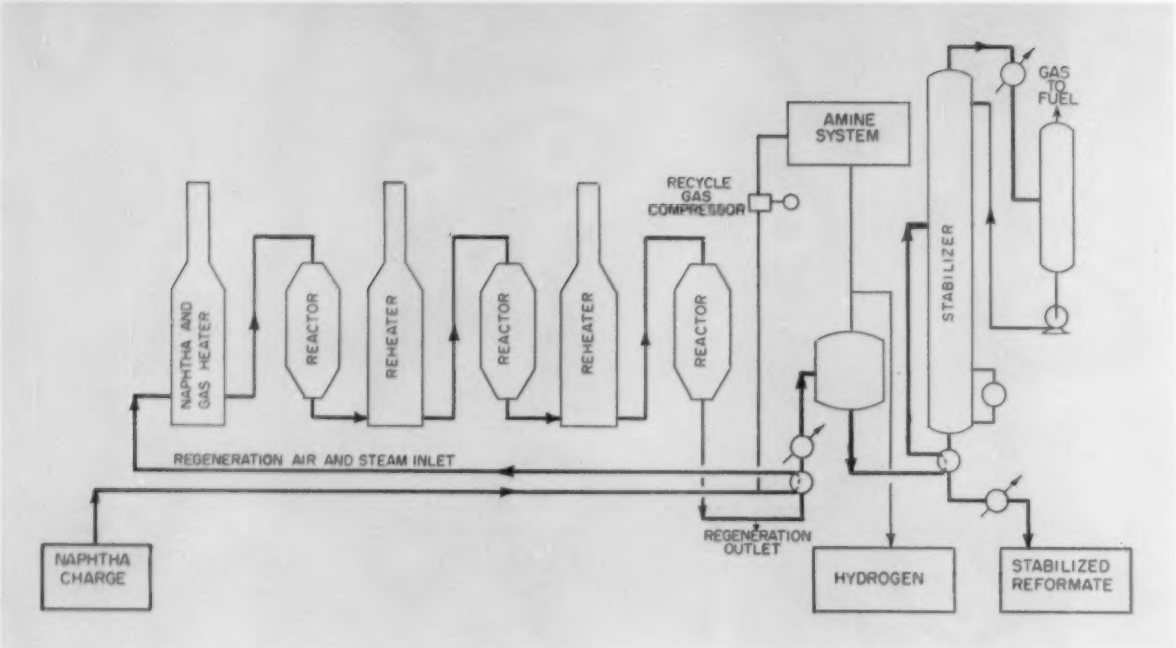
Process . . . The flow diagram illustrates a typical motor-fuel Platformer. The unit may be considered conveniently in three sections: feed preparation, reaction, and stabilization.

A feed-preparation section at the Platformer is omitted if the external facilities are adequate. Typical feed preparation integrated with the unit often consists of a fractionator used to prepare the desired boiling range of reactor charge from a wider boiling range raw gasoline. Light components which would not be appreciated by Platforming are removed overhead. Sometimes a small amount of bottoms is removed to prevent high-boiling materials from reaching the catalyst. Reactor charge is then drawn as a sidecut.

The reaction section consists of a feed heater, several reactors (in this case four) with interheating between reactors to supply the endothermic heat of reaction, exchangers, and a product separator. Hydrogen-rich gas from the separator is recycled to the reactors to avoid carbonization of the catalyst.

Stabilization is conventional, and rerunning is not required.

Yield-octane relationships for two widely different stocks are shown on accompanying graphs.



Catforming

CATFORMING is a fixed bed catalytic process for increasing the octane ratings of gasoline fractions. In commercial operation since 1952, 15 units are on stream in the United States and Canada. Additional domestic and foreign units are scheduled for startup this year.

Flow . . . The process consists of mixing the incoming naphtha with a recycle hydrogen stream, heating to reaction temperature, and passing the mixture in vapor phase over three catalyst beds in series. Because the net heat effect is endothermic, it is necessary to reheat the stream between the catalyst beds. The gasoline is condensed and stabilized in a conventional manner. When processing high-sulfur naphthas, hydrogen sulfide is scrubbed from the recycle hydrogen before rejoining the feed naphtha stream.

Process features . . . Catforming catalyst is a combination of platinum and synthetic silica-alumina designed to promote dehydrogenation, isomerization, cyclization, hydrocracking, and hydrodesulfurization. The use of silica-alumina eliminates the need for cracking promoters and gives the catalyst complete tolerance for water and nitrogen compounds in the feed or recycle streams.

This obviates drying of the feed or the recycle stream following the amine unit. The catalyst is highly selective, and has excellent stability. Hydrogen purity ranges from 90 to 95 per cent, and cracking to methane and ethane is minimized. The catalyst is readily regenerable with a simple air-in-stream mixture.

Regeneration . . . Catforming catalyst will perform over a range of pressures from 250 to 700 psi. The choice of pressure depends on the feed stock and the desired results. Low pressure favors dehydrogenation to aromatics and is used with selected cuts for the production of aromatics. With heavy paraffins, however, lower hydrogen pressure increases the rate of carbon laydown on the catalyst.

For average crude naphthas being processed only for octane improvement an operating pressure of 500 psi. is most economical both from the standpoint of initial investment and operating cost. If such stocks are run at lower pressures frequent regenerations are required, which means either increased unit down time or increased investment for a fourth "swing" reactor and accompanying equipment.

In normal Catformer operation 6 months to a year will elapse before a regeneration is required. No special equipment is required for regeneration, it being necessary only to have a connection to admit air and steam ahead of the first reactor, and exhaust the waste gas following the last reactor. Besides extending catalyst life, regeneration offers a valuable safeguard in the event of an upset such as interruption of recycle by compressor failure or carryover of lubricating oil from compressors to the catalyst beds.

Process Performance

Any naphtha in the gasoline boiling range is a potential feed for Catforming. With certain stocks such as cracked gasolines, the chemistry of the process requires that it be charged in mixture with straightrun so that sufficient hydrogen will be produced to maintain reaction balance. Also, with very high sulfur stocks it may be more economical to hydrodesulfurize ahead

"Any naphtha in the gasoline boiling range is a potential feed."

of the Catformer rather than doing it in the Catformer itself. For moderate sulfur contents, however, the simplified amine system on the recycle gas stream is all that is required.

Results . . . Commercial experience is available on a wide variety of stocks. Process data are given in Table 1 for the 2,500-bbl. per day Catformer of United Refining Co., Warren, Pa. The charge stock (full-boiling-range mixed-crude naphthas) is brought from 51.0 octane to 95.1 leaded octane (3 cc. TEL) at a yield of 92.5 per cent. The unit, constructed by Blaw-Knox, is currently at a catalyst life of 68 bbl. per pound (as of mid-February 1955) and has not yet been regenerated.

Hydrogen produced in the Catformer is used in a Unifiner to hydrogenate middle distillates for quality improvement. This unit (licensed by Union Oil Co.) was the first Unifiner to be placed in commercial operation. Other installations are using the product hydrogen for hydrogenation and ammonia synthesis, which latter operation is facilitated by the high hydrogen purity.

Catforming is a development of and is licensed by Atlantic Refining Co.

TABLE 1—PROCESS DATA
United Refining Co.

Charge stock:	
Octane, F-1 clear	51.0
Gravity, °A.P.I.	63.5
Sulfur, per cent	.043
R.v.p.	9.1
A.S.T.M. distillation:	
I.b.p.	100
30 per cent	211
50 per cent	246
90 per cent	337
Product (stabilized to 10 psi. R.v.p.):	
Octane, F-1 clear	82.5
3 cc. TEL	95.1
Sulfur, per cent	<.001
Yield, volume per cent (based on butane free feed)	92.5

McBride Unit

The first Catformer in operation is that at the McBride refinery, La Blanca, Tex.

Process results from the McBride unit on Donna and La Blanca stocks are presented in the accompanying table. The 10-lb. R.v.p. yield of reformate and other yields are shown as a per cent of the debutanized charge. The La Blanca stock is being upgraded to 84.5 F-1 octane at 3 cc. TEL at a yield of 96 volume per cent.

On the Donna stock a 93.5 F-1 octane at 3 cc. TEL is obtained at a yield of 99.9 per cent. The selectivity of this catalytic reforming operation is particularly evident from the low yields of methane and ethane and the high purity of the recycle hydrogen stream.

The bulk of the material produced lighter than pentanes is propane and butane. The stabilizer may be operated as a depropanizer producing a 7-10-lb. R.v.p. product or alternately as a debutanizer to produce a low-vapor-pressure reformate.

When operated as a debutanizer, the stabilizer overhead is condensed and sent to storage as L.P.G. In this installation maximum economy results from reforming to a high yield; as a result, reforming severity has been moderate with reactor temperatures being held at 900° F. maximum.

Units flexible . . . Sufficient flexibility exists in the unit that competitive regular and premium gasolines can now be produced from either charge stock without the addition of extraneous blending materials. In addition, it has been possible for McBride to substantially increase the octane quality of both regular and premium gasolines.

REFORMER FEED INSPECTIONS—McBRIDE UNIT

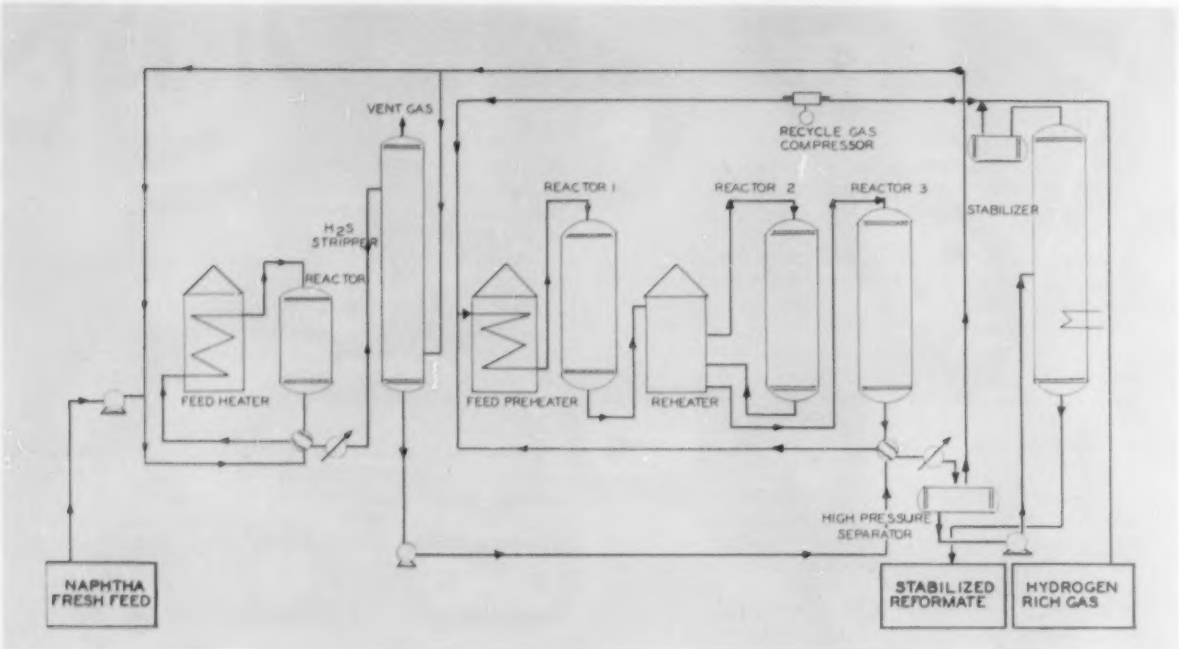
Stock—	Donna	La Blanca
Gravity	56.3	62.7
R.v.p.	3.5	5.0
I.b.p.	126	116
10 per cent	200	198
30 per cent	239	240
50 per cent	267	275
70 per cent	297	303
90 per cent	340	341
E.p.	379	382
F-1 octane clear	56.0	30.8
Per cent paraffins	51.7	76.5
Per cent naphthenes	35.3	19.1
Per cent aromatics	13.0	4.4

McBRIDE REFORMING RESULTS

Stock—	Donna	La Blanca
Yields, per cent of feed:		
10-lb. R.v.p. reformate, volume per cent	99.9	95.9
Xs butanes, volume per cent	—3.2	—0.2
Propane, volume per cent	4.6	4.2
Ethane, weight per cent	0.3	0.3
Methane, weight per cent	0.1	0.1
Hydrogen, weight per cent	0.6	0.2
Octanes, F-1:		
10-lb. R.v.p. reformate, clear	80.2	66.4
Plus 3 cc. TEL	93.5	84.5

CATFORMING UNITS IN OPERATION

	Capacity, bbl./day
Anderson-Prichard Oil Corp., Cyril, Okla.	1,100
Atlantic Refining Co., Philadelphia, Pa.	11,100
Atlantic Refining Co., Port Arthur, Tex.	8,000
Canal Refining Co., Church Point, La.	750
Douglas Oil Co. of Calif., Bakersfield, Calif.	2,500
Gladewater Refining Co., Gladewater, Tex.	700
Husky Oil Co., Cody, Wyo.	1,500
Malco Refineries, Inc., Prewitt, N. M.	1,000
Mid-Continent Petroleum Corp., Tulsa	7,500
Mohawk Petroleum Corp., Bakersfield, Calif.	2,500
Port Fuel Co., Inc., Brownsville, Tex.	1,000
Union Oil Co. of California, Cut Bank, Mont.	600
United Refining Co., Warren, Pa.	2,600
Williston Basin Ref. Corp., Williston, N. D.	300



Houdriforming

HOUDRIFORMING is a fixed-bed catalytic reforming process utilizing a catalyst containing platinum for conversion of straightrun and cracked petroleum naphthas to high-octane motor gasoline, aviation blending stocks and aromatics.

Five Houdriforming units are now on stream with a capacity of 32,330 bbl. per day, and 57,730 bbl. of additional daily capacity is being engineered and constructed.

Catalyst . . . At moderate severities, Houdriforming is operated for either high-octane motor fuel or aromatics, in a truly continuous manner without need for regeneration of catalyst. The process lends itself readily to catalyst regeneration in situ. This type of operation has been demonstrated commercially, and is required only for high-severity operations.

The Houdry Type 3 catalyst is used in Houdriforming. This fulfills exacting requirements of catalyst strength, activity, and selectivity. The catalyst is well balanced to carry out the reactions involved—dehydrogenation, isomerization, hydrocracking, and desulfurization.

Guard case . . . A pretreating or "guard case" stage incorporated as an integral part of the process scheme permits a wide selection of feed stocks and appreciably lengthens the effective life of catalyst in the main reactors as a result of the high degree of desulfurization and purification of the charge where this is required.

Features . . . (1) The Houdriforming process efficiently reforms a variety of charging stocks that differ widely in chemical composition and boiling range. It is possible to process naphthas with end boiling points up to 400° F. (2) It is possible to upgrade low-octane straightrun naphthas by as many as 40 to 70 octane numbers, with impressively high liquid volume recovery. (3) Virtually complete desulfurization of the charging stock is realized. With the guard case integrated "on the line," stocks having high sulfur content may be readily handled without scrubbing of recycle gases. Stabilized reformates require no further treatment before blending to refinery pool gasolines. (4) Houdriforming straightrun naphthas in production of aromatics succeeds in conversion of naphthenes to benzene, toluene, and xylenes at yields up to 100 per cent of theoretical values. Aromatization of paraffins also proceeds to a significant measure. (5) Hydrogen of high purity is produced as a byproduct of Houdriforming. In operation for aromatics, the process gives hydrogen of greater than 95 per cent purity. In motor-gasoline operations, Houdriforming produces large volumes of hydrogen of 85-90 per cent purity, recoverable for use in other processes.

Houdriforming process . . . Houdriforming utilizes two or more fixed-bed catalytic reactors in series, with interstage reheaters.

When the guard case is integrated in the operation, as also shown in the diagram, the naphtha charge is pumped through heat exchange to union with hydrogen from the flash drum of the main reactor series, and the combined stream is fed to the guard-case heater and reactor. After heat exchange, the guard-case effluent goes to a stripper tower receiving another portion of the flash-drum hydrogen. H_2S is vented from the stripper.

The desulfurized effluent again undergoes heat ex-

TABLE 1—HOUDRIFORMING OPERATIONS FOR MOTOR GASOLINE PRODUCTS

Charge stock—	Low paraffin content naphtha from mixed naphthenic crudes		Intermediate paraffin content naphtha from East Texas crude		High paraffin content naphtha from Kuwait crude	
Gravity, °A.P.I.	45.8		55.3		52.9	
A.S.T.M. distillation, °F.:						
I.b.p.	255		188		244	
10 per cent	285		215		289	
30 per cent	300		232		306	
50 per cent	316		252		320	
70 per cent	334		280		338	
90 per cent	361		317		366	
E.p.	401		368		398	
F-1 clear octane	61.3		55.6		23.5	
F-1 + 3cc. TEL	79.0		76.3		46.1	
R.v.p.	0.6		0.7		0.6	
Sulfur, weight per cent	0.012		0.006		0.10	
Composition, vol. per cent:						
Paraffins	31		44		64	
Olefins	0		0		1	
Naphthenes	46		42		20	
Aromatics	23		14		15	
Hydroforming data—	Operation— Mild	Severe	Mild	Severe	Mild	Severe
Yields, based on charge:						
Debutanized reformate, vol. per cent	88.3	80.6	91.0	83.5	87.4	80.4
Butanes, vol. per cent	3.9	7.0	2.7	6.2	6.1	9.3
Propane, wt. per cent	2.0	5.0	1.2	3.8	2.8	4.7
Ethane, wt. per cent	1.0	2.9	0.8	2.4	1.5	2.8
Methane, wt. per cent	0.6	1.8	0.5	1.0	1.1	2.2
Hydrogen, wt. per cent	2.0	1.8	1.6	1.3	0.7	0.7
Debut. reformate						
F-1 clear oct.	92.0	*101.0	80.0	92.0	76.8	90.0
F-1 + 3cc. TEL	99.2	*104.2	92.5	99.5	91.0	98.3
Gravity, °A.P.I.	39.7	36.5	52.7	45.8	50.7	47.7
A.S.T.M. distillation, °F.:						
I.b.p.	170	148	173	149	141	130
10 per cent	248	230	212	196	216	195
30 per cent	282	280	234	222	259	250
50 per cent	306	306	260	248	284	283
70 per cent	322	320	284	281	308	299
90 per cent	378	375	323	325	340	349
E.p.	460	465	379	392	413	426
R.v.p., psi.	1.0	1.9	1.9	3.0	2.1	3.6
Sulfur, weight per cent	0.002	0.002	<0.001	0.002	<0.001	<0.001

*Octanes above 100 are extrapolated by method of Deters, J. F., Pet. Ref. Vol. 30, No. 6 (June, 1951).

TABLE 2—PROCESSING 230-394 F. PARAFFINIC NAPHTHA FROM NATURAL GAS CONDENSATE

Yields:	A— Wt. %	Vol. %	B— Wt. %	Vol. %
Debutanized gasoline	80.1	78.1	83.2	80.8
Total C_4	7.6	9.9	7.1	9.2
Total C_3	6.9		5.2	
Total C_2	3.0		2.3	
Total C_1	1.5		1.1	
Total H_2	0.9		1.1	
Total	100.0		100.0	
Stabilized gasoline (10 lb. R.v.p.)		86.7		89.5
Excess C_4		1.3		0.5
Inspections—	Fresh charge	Debut. prod.	Stab. prod.*	Debut. prod.
Gravity, °A.P.I.	58.8	54.0		53.2
A.S.T.M. dist., °F.:				
I.b.p.	230	127		131
10 per cent	248	179		183
50 per cent	278	251		264
90 per cent	351	326		345
E.p.	394	412		432
Sulfur	0.003	Nil		Nil
R.v.p.		2.7	10	3.0
Octanes:				
F-1 clear	24.6	82.3	83.1	80.1
+ 3cc. TEL	55.4	93.3	94.8	93.0
Chem. composition, volume per cent:				
Paraffins	77	57		57
Olefins	0	2		2
Naphthenes	17	0		0
Aromatics	6	41		41

*Tests on product after adding C_4 for 10 lb. R.v.p.

change and is pumped to the Houdriforming preheater, together with recycle hydrogen from the reforming stage separator. Partial conversion of the charge takes place in each of the three catalytic reforming reactors, and since the hydrocarbon stream sustains a drop in temperature in each reaction, it is reheated prior to entering each reactor in the series.

The effluent is heat-exchanged and cooled after emerging from the final reactor, and is collected in the high-pressure flash drum. Hydrogen-rich gas from this flash drum is recirculated with the charge to the Houdriforming reactors. Also, a small quantity of this gas flows to the guard-case section.

Liquid from the flash drum passes to the stabilizing tower, which vents gas to refinery fuel and from which stabilized reformate is withdrawn for end-product use.

When the process is operated for motor gasoline, the stabilized reformate is a finished product, suitable for blending directly into refinery pool gasoline. When the process is operated for aromatics, the reformate is fed to other processes for extraction and purification.

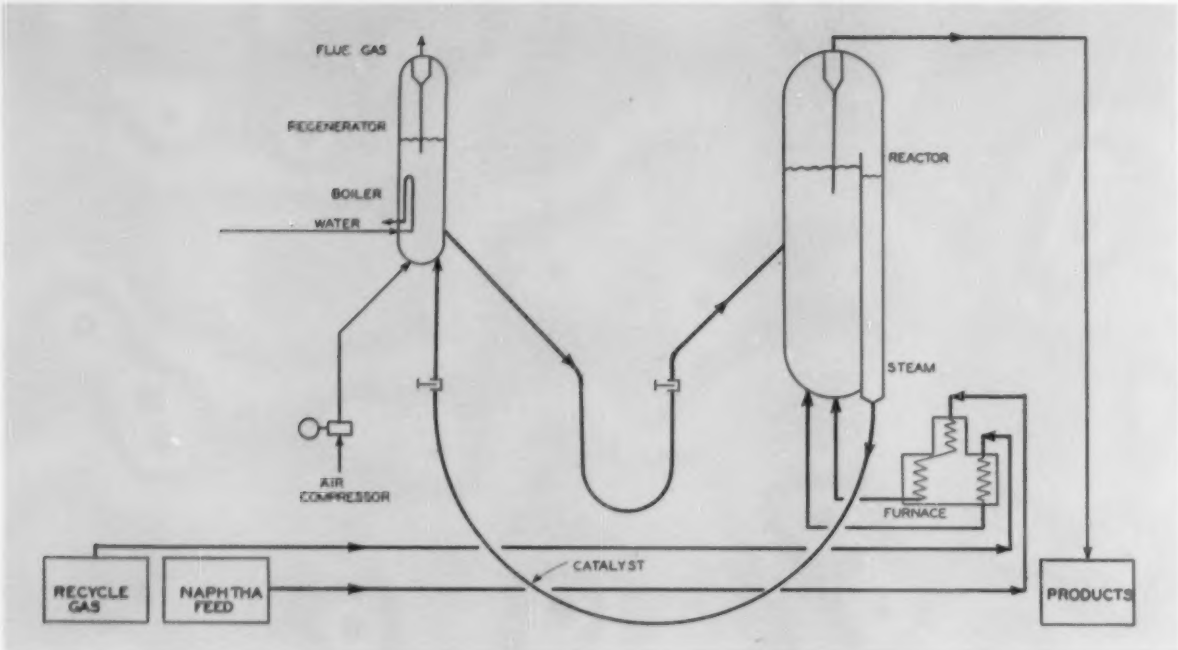
Major variables in Houdriforming are temperature, space velocity, pressure, and hydrogen-to-oil-recycle ratio. By proper control of variables, the severity of the reforming process may be widely varied depending upon end products desired. Typical operating conditions are usually within these limits:

Temperature, °F.	875-950
Pressure, psig.	250-600
Space velocity, v./hour/v.	1.5-5.0
Hydrogen—oil mole ratio	4-10

Performance data . . . Naphtha charge stocks have been evaluated from a number of domestic and foreign crudes representative of extremes in physical and chemical properties normally to be encountered.

Typical yield-octane data from Houdriforming for motor-gasoline products are presented in Tables 1 and 2. Naphthas shown in Table 1 indicate the influence of chemical composition on yield. Paraffin content varies from 31 to 64 per cent. Yields are shown for mild and severe operation in each case.

This process is licensed by Houdry Process Corp.



Hydroforming

FLUID Hydroforming is a flexible, fully continuous process for converting virgin and cracked naphthas to high-octane gasoline. Using the fluidized solids technique, it employs a molybdena-alumina catalyst. At present, 144,000 bbl. per day of capacity is being installed in the United States and abroad.

A great variety of feed stocks has been reformed to products in the 90 to 100-octane number range. Both narrow and wide-cut feeds have been processed. There is no limitation on feed end point, and feeds containing cracked stocks can be reformed with excellent yields with pretreatment for olefin saturation or sulfur removal.

The catalyst is cheap and rugged and not susceptible to poisoning by sulfur or water. The products are essentially sulfur free. Selectivity of the catalyst does not fall off with continued use.

Operation . . . The finely divided catalyst, behaving much like a fluid, circulates continuously between the reactor and the regenerator. The preheated naphtha feed enters the bottom of the reactor where it meets a hot isothermal bed of catalyst. The reformed products leave the catalyst bed and pass through separators where entrained catalyst is removed and returned to the bed. The overhead products are heat exchanged, cooled and separated into gaseous and liquid products.

After stabilization, the liquid product is removed as high-octane gasoline. A portion of the gaseous product is compressed, heated, and recycled to the reactor to supply additional heat.

To eliminate carbon which deposits on the catalyst during the reaction, a portion is continuously withdrawn and allowed to flow to the regenerator. Here carbon is burned off with air which liberates large quantities of heat. The heat may be used to produce steam or preheat the feed. The hot regenerated catalyst returns as a fluidized stream to the reactor, supplying some of the heat required and completing the continuous cycle.

Yields from Fluid Hydroforming at any octane level depend on the feed-stock quality.

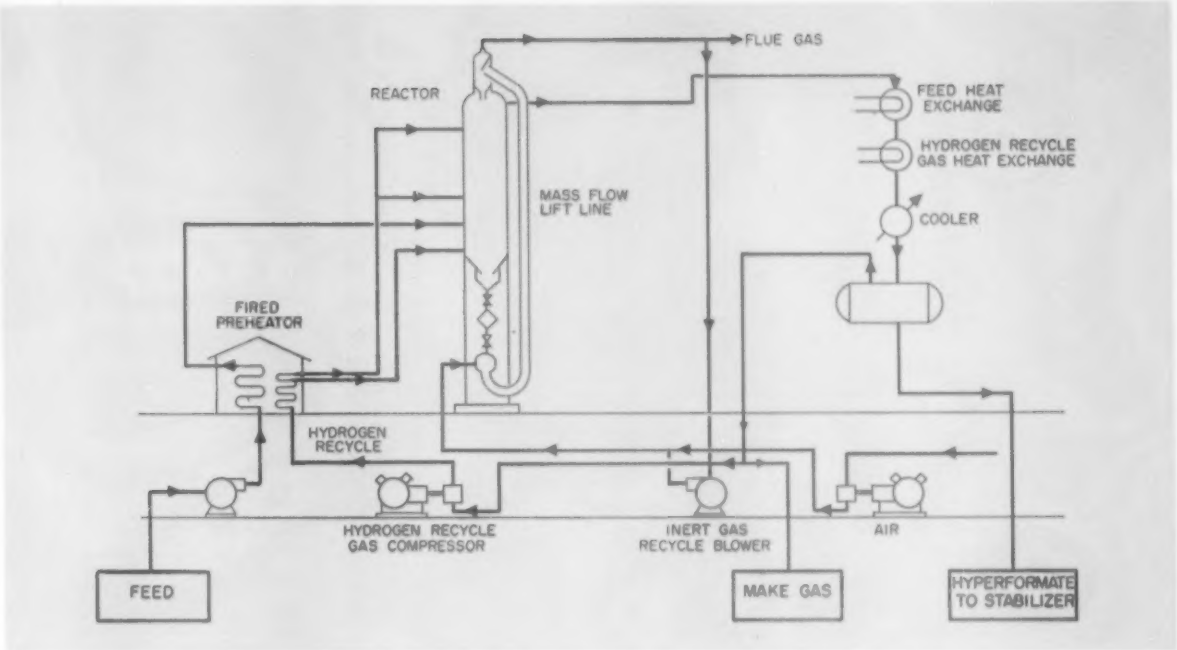
Prepared by Esso Research & Engineering Co., New York.

Editor's Note: Model II Hydroformer

In this unit an inert material, of larger size than the catalyst and more dense than the catalyst, circulates with the catalyst between the reactor and regenerator. The table compares operating conditions of Model I and Model II Fluid Hydroformers.

TABLE 1
Hydroforming of a 250° to 325° F. West Texas Virgin Naphtha to Produce a 92-Octane Number (A.S.T.M. D 908, Research Method) C_5+ Gasoline Without TEL Addition

	Process	
Reactor:	Model I	Model II
Pressure, psig.	200	200
Temperature, °F.	895	900
Recycle gas:		
Rate, cu. ft. per bbl.	4,700	2,000
Preheat temperature, °F.	1,200	1,000
Naphtha:		
Preheat temperature, °F.	1,000	1,000
Solids circulation, lb. per lb. of naphtha feed:		
Catalyst (catalyst-to-oil ratio)	1.0	0.6
Shot (shot-to-oil ratio)	None	3.1
Regenerator:		
Pressure, psig.	200	200
Temperature, °F.	1,125	1,125
Cooling-coil duty, B.t.u. per lb. of feed	100	None
Air standard, cu. ft. per bbl. of feed	541	685



Hyperforming

HYPERFORMING is currently applicable to the upgrading of straightrun gasolines or straightrun-cracked gasoline mixtures, or both, to produce a product essentially free from nitrogen and sulfur, elevated in octane, reduced in boiling range, and gum stable.

Straightrun and cracked-gasoline fractions boiling between 150° and 450° F. may be processed. Since the process incorporates regeneration facilities, there is no critical limitation on charge-stock boiling range or octane level of the product.

Description . . . The Hyperforming process is a continuous regenerative catalytic reforming process which utilizes the new Hyperflow (mass flow) catalyst-handling technique. The catalyst is circulated at very low velocities and virtually no impact by this new Hyperflow lift principle resulting in minimum attrition loss. It carries out the reforming of straightrun naphthas, as well as blends of straightrun and cracked stocks, to effect major uplifts in gasoline quality with high overall liquid yields.

The reactor utilizes a moving bed of special cobalt-molybdate-type catalyst. Operating pressure is near 400 psi. A recycle stream of hydrogen is employed to carry out the catalytic reactions. Reactor temperatures are in the range of 800° to 900° F. The reactor incorporates solids-handling features which provide precise control of catalyst motion at all points. The catalyst moves downward through the reactor under gravity flow, and is returned back through the top of the reactor by means of mass conveyance in a catalyst-transfer line. Simultaneous with this vertical lift, regeneration is carried out. The naphtha being processed is heat-exchanged with the reactor effluent and is introduced into the bottom of the reactor at a pressure of approximately 400 psi.

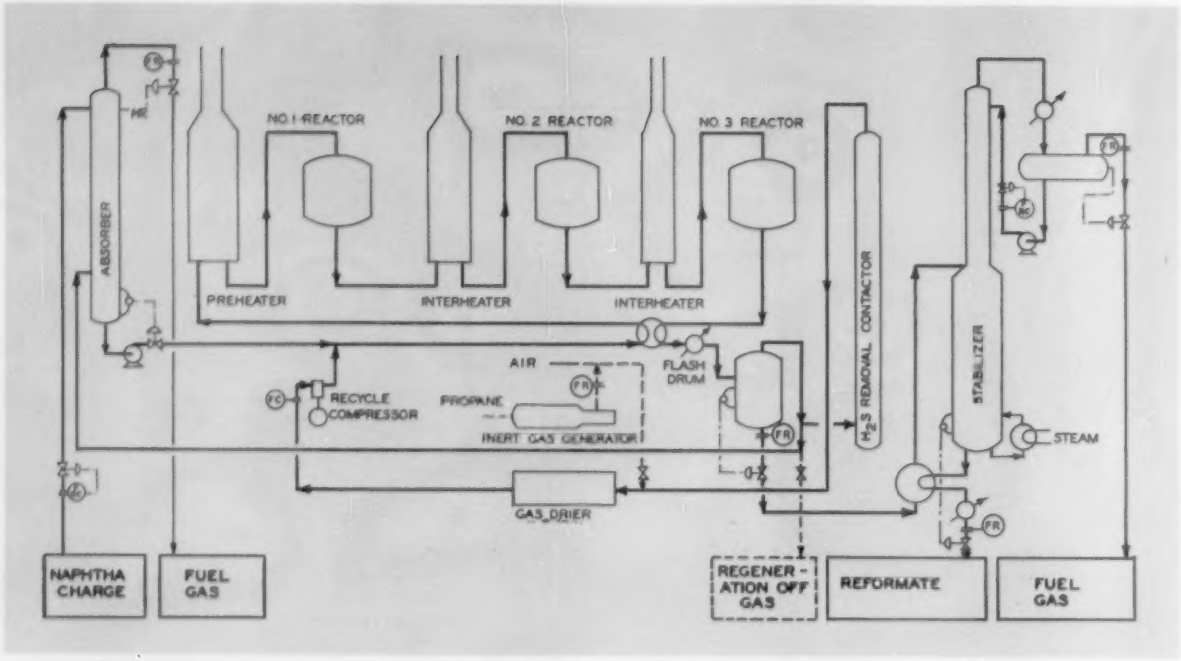
The naphtha vapor with the recycle gas flows upward countercurrent to the catalyst, and hot hydrogen is introduced at several interheating points. The naphtha leaves the top of the reactor as a thoroughly refined product.

Blends of straightrun gasoline and cracked stocks can be refined simultaneously by Hyperforming. In the course of upgrading, the hydrogen released in the dehydrogenation of naphthenes is reused for the elimination of large quantities of sulfur, nitrogen, and oxygen compounds in inferior stocks. Olefins are saturated as well. This exchange of hydrogen between the straightrun gasoline and the inferior stocks leads to refined gasoline without external hydrogen production.

Reactions of the process included the combination of dehydrogenation of naphthenes to aromatics as well as hydrogenation to eliminate gasoline contaminants. Dehydrocyclization of paraffins is a feature leading to high-quality products from paraffinic feed stocks. A substantial amount of hydrocracking of the higher-molecular-weight hydrocarbons occurs together with isomerization of paraffins and naphthenes. Improved volatility of the product is a feature of the operation which increases the potential volume of charge stocks to the reforming plant with a corresponding increase of gasoline production from a given refinery.

Operating conditions . . . Hyperforming is carried out at pressure levels on the order of 400 psi. and the reactor temperatures are in the range of 800° to 900° F. Hydrogen recycle is utilized and space velocity is adjusted to the particular characteristics of the stock being processed.

This process is licensed by Union Oil Co. of California.



Catalytic Reforming

SINCLAIR-BAKER RD-150 catalytic reforming catalyst is designed to economically upgrade straight-run or cracked naphthas to high octane motor fuels, aviation blending stocks, and aromatics. This platinum-type catalyst was first announced in May 1953, and since that time, units totaling 68,000 bbl. per day capacity have been placed in operation or are under construction.

The RD-150 catalyst has high paraffin cyclization, naphthene dehydrogenation, and selective isomerization activities, low hydrocracking activity, and is resistant to permanent poisoning effects of normal concentrations of sulfur, metals, and water in the virgin naphthas. In addition to these properties, it may be readily regenerated so that high activities may be maintained in the event of activity degradation due to operational upsets.

The design of a typical processing system is shown on the flow sheet. Naphtha feed is charged to the unit through an absorber where butanes and heavier fractions are removed from the net flash gas. The absorber bottoms are then mixed with the hydrogen-rich recycle gas and exchanged with reactor effluent before entering the coils of the preheater.

From the preheater the vaporized naphtha and recycle gas are passed through three fixed-bed, adiabatic reactors, with interheating between the reactors. The use of interheating is required as the principal reforming reactions are endothermic. During the processing cycle, the reactor inlet temperatures are slowly increased to compensate for the gradual decline in catalyst activity.

Hydrogen recycle . . . The reactor effluent is then exchanged against fresh feed, cooled to atmospheric temperature, and passed into a high-pressure flash drum, in which the effluent is split into two streams. The hydrogen-rich gas is compressed and recycled through gas-treating equipment to the inlet naphtha system, with the net gas make released to the absorber for butane and reformate recovery and then to the fuel system. Alternately this valuable hydrogen may be used for desulfurization or hydrogenation.

The liquid product flows to a stabilizer where the reformate is stabilized to the desired vapor pressure. The processing cycle shown includes an H_2S removal contactor and a fixed-bed alumina drier. The inclusion of this equipment is dictated for the processing of high-sulfur naphthas with the drier provided to remove water absorbed from the H_2S removal tower. The inclusion of both a gas-treating system and an absorber is based upon the economics of the particular installation under consideration.

	Mid-Continent
Fresh feed:	
Gravity, °A.P.I.	54.0
I.b.p., °F.	249
10 per cent, °F.	264
50 per cent, °F.	287
90 per cent, °F.	333
E.p., °F.	365
R.v.p., psi.	
Octanes:	
Research clear	39.3
Research + 3 cc. TEL	63.8
Chemical composition:	
Paraffins, Volume per cent	49.0
Naphthenes, volume per cent	43.0
Aromatics, volume per cent	8.0

"Unit can be tailor-made for processing of any naphtha charge stock."

YIELD DATA FROM PROCESSING OF MID-CONTINENT NAPHTHAS

Operating pressure—	Low		High	
Research clear octane—	85	95	85	95
Yields:				
Hydrogen, weight per cent	1.8	2.2	1.7	1.8
Dry gas, weight per cent	3.6	6.2	5.1	8.8
Butanes, volume per cent	2.6	4.6	3.7	6.3
C_4-e.p., volume per cent	91.3	88.0	91.1	87.2
C_5-e.p., volume per cent	88.7	83.4	87.4	80.9
10-psi. R.v.p. gasoline, volume per cent	103.1	95.6	100.6	91.3
Reformate:				
C_5-e.p. gravity, °A.P.I.	46.3	43.9	47.8	45.6
C_5-e.p. R.v.p., psi.	1.6	2.6	2.3	3.7
C_5-e.p. octanes:				
Motor method, clear	78.8	86.3	78.8	86.3
Motor method + 3 cc.	87.6	91.7	87.6	91.7
Research method, clear	85.0	95.0	85.0	95.0
Research method + 3 cc.	95.3	101.0	95.3	101.0

Regeneration of the catalyst becomes desirable when the accumulation of carbonaceous materials has reduced the activity and selectivity of the catalyst below acceptable economic limits. The regeneration is accomplished by burning the coke deposits in a stream of dilute air, with the equipment required shown by dotted lines on the flow sheet.

Actual regeneration is accomplished by stopping the naphtha flow, purging and pressuring the unit with inert gas, and then admitting air while circulating flue gas until the burning is complete. Naphtha processing is then resumed after purging the inert gas from the system. Because of the infrequency of regeneration, the installation of extra reactors, heaters, manifolding, etc., is not usually required.

Versatile processing . . . The regenerative ability of the RD-150 catalyst permits wide variation in operating conditions, and the unit can thus be "tailor-made" for the processing of any naphtha charge stock. The operating conditions can be varied over the following ranges; 200-750 psig., 850°-970° F. reactor inlet temperatures, 1 to 5 weight hourly space velocity based upon fresh feed, and 3 to 10 molal gas recycle ratio. The resultant processing cycle length and the catalyst costs are dependent upon the naphtha charge stocks, the processing conditions, and the required reformate qualities.

High-pressure operation, around 500 psig., with high naphthene content feeds, and at low severity levels in the range of 85 research clear octane allow long processing cycles, infrequent regenerations, high design space velocities, and low catalyst costs. In contrast, low-pressure operations, around 200 psig., with high-paraffin-content feeds, and at high severity levels in the range of 95 research clear octane cause shorter processing cycles, more frequent regenerations, low design space velocities, and higher catalyst costs.

Typical yield data are shown for a Mid-Continent naphtha for these two types of operations. For the octane ranges considered, the low-pressure process will produce less dry gas, more hydrogen, and more C_5-e.p. reformate than will the high-pressure operation. Also, at the same reformate octane, the low-pressure operation will produce substantially more 10-psi. R.v.p. gasoline. Where additional butanes are not available, so that the C_4-e.p. reformate yield must be maximized, there is less yield advantage for the low-pressure operation.

Catalytic reforming employing RD-150 catalyst permits latitude in both design and operation for the flexible and economical processing of naphtha feed stocks for varying market conditions. The resistance to permanent poisoning and the regenerative feature allows the catalyst to be maintained at substantially virgin activity throughout its life. This is of particular importance because of the inherently high costs of platinum catalysts.

The RD-150 catalyst is supplied by Baker & Co., Inc. The firm will process used catalysts for recovery of the platinum. M. W. Kellogg Co. is offering the RD-150 catalyst for fixed bed units.

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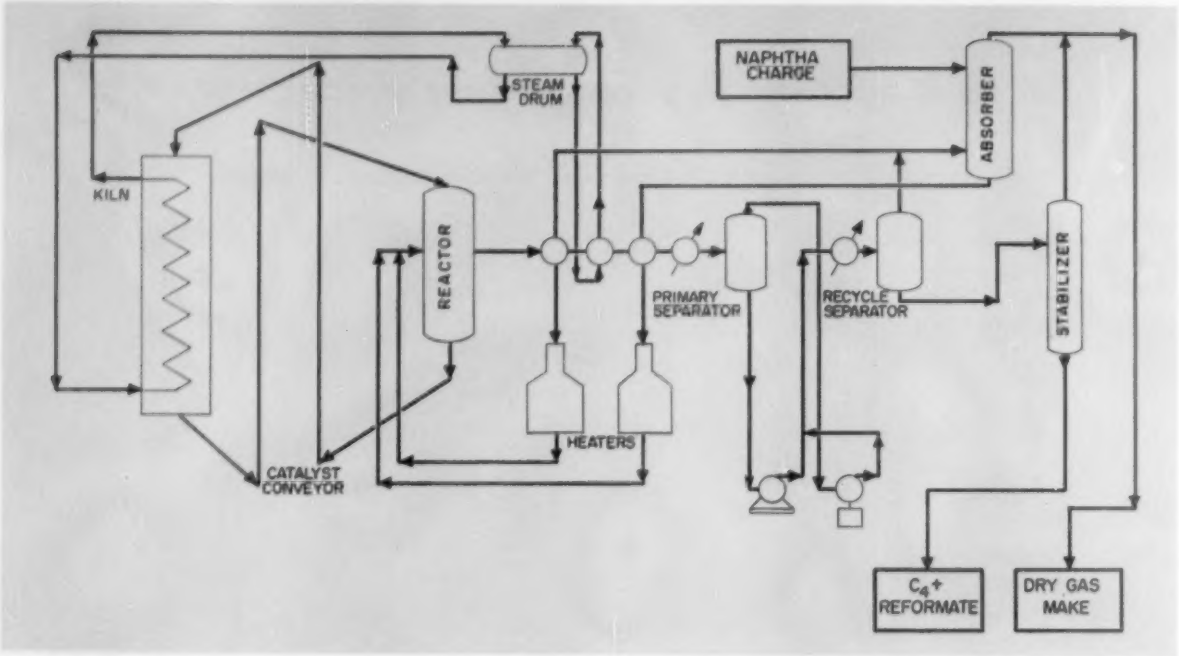

Thermofor Catalytic Reforming

THE Thermofor catalytic reforming (T.C.R.) process employs a synthetic chromia-alumina bead catalyst which circulates through a moving-bed system comprising a reactor and a kiln; thus provision is made for continuous reaction, with regeneration of the catalyst. As implied by the term "Thermofor," the design of this system embodies many of the principles applied successfully in the well-known T.C.C. (Thermofor catalytic cracking) process over the past 10 years.[1,2]

The major process variables are pressure, gas-recycle ratio, reaction temperature, space velocity, and catalyst-to-naphtha ratio. The effect of these variables is discussed as follows:

... **1. Pressure.** Reaction pressures have been studied over a range from atmospheric to 500 psig. When reforming proceeds to a given octane number, lower pressures result in a more satisfactory yield of 10-lb.-Reid-vapor-pressure gasoline and a higher hydrogen and coke production. Bench-scale data indicate the desirable pressure range to be between 100 and 200 psig.—the level within the range depending on the stock and depth of reforming.

... **2. Gas-recycle ratio.** Gas-recycle ratios up to 12 moles of gas per mole of naphtha have been explored. As the recycle ratio is increased, coke "make" decreases appreciably and gasoline yield increases slightly, whereas the hydrogen content of the recycle gas remains fairly constant. In adiabatic operation gas recycle also aids in supplying reaction heat. Practical recycle ratios appear to be in the range of three to nine.

... **3. Temperature.** After other process conditions are fixed, reactor temperature is the principle variable for controlling the reforming severity and octane number of the product. The temperature severity required depends on the stock, and it can range from about 950° F. on an easily reformed stock to 1,000° F. for a refractive-type stock for reforming to an F-1 octane-number level of 100 upon the addition of 3 ml. TEL per gallon.

... **4. Space velocity.** As a means of controlling severity, space velocity is interchangeable with temperature over a fairly wide range; i.e., lower temperatures can be used with lower space velocities in order to produce the same yield-octane-number result. A space velocity of about 0.7 volume of naphtha per unit reactor volume per hour is satisfactory for the temperature range indicated previously.

... **5. Catalyst-to-naphtha ratio.** Catalyst-to-naphtha ratio can be varied over a wide range, with no marked effect on product yields and quality, provided coke concentration on the catalyst does not become excessive. Because coke deposition with this catalyst is relatively low, it is possible to operate with very low catalyst-circulation rates compared to those used in catalytic cracking.

... **6. Yield-octane-number relationship for various stocks.** A summary of representative yield-octane-number data obtained on various stocks in a bench-scale program was included in the paper by Hughes et al.[3] It was shown that the yield-octane-number relationship of the various naphthas correlates well with the conventional characterization factor K.

A schematic flow diagram for a T.C.R. unit is illustrated above. Starting with the reactor, the effluent therefrom flows through heat exchange, with recycle gas and naphtha, to a final condenser. The condensate and gas are then separated in a receiver which operates approximately at a pressure of 140 psig. and a temperature of 100° F. The gas from this receiver is compressed to approximately 210 psig. by the recycle-gas compressor. The condensate is pumped up to the

same pressure, after which both are recontacted and cooled before they flow to the recycle separator. The condensate from the recycle separator is pumped to a depropanizer or to other suitable stabilization facilities.

The net gas production flows to an absorber, and thence to the fuel line. Naphtha charge is pumped over the absorber, in order to obtain the desired recovery of light hydrocarbons from this gas; and it is pumped from the base of this absorber through heat exchange, thence through the naphtha heater which raises the temperature to approximately 900° F., and finally into the reactor. The recycle gas, which is the main stream to leave the recycle separator, passes first through a dryer, next through heat exchange with the reactor effluent, and finally through the recycle heater which heats this material to a temperature of approximately 1,150° to 1,200° F. The hot recycle gas mixes with the heated naphtha just before both enter the reactor.

Catalyst flow . . . Catalyst flows downward through the reactor in a compact moving bed. Inasmuch as the catalyst flow is comparatively small, ranging from approximately 5 to 50 tons per hour for units which have throughputs up to 20,000 bbl. per stream day, it may be transported from the base of the reactor to the top of the regenerator with bucket elevators or with other suitable lift equipment. The regenerator is a conventional multizone type of Thermofor kiln, similar in operating principle to those installed on T.C.C. units.[1,2,4] This type of kiln is well suited to the low catalyst-circulation requirements of the T.C.R. process, and it does not embody any new or unusual design features.

The T.C.R. kiln operates at substantially atmospheric pressure. A kiln for a 15,000-bbl. per day T.C.R. unit would normally be designed to burn about 2,000 lb. of coke per hour, with a catalyst circulation of approximately 25 tons per hour. Regeneration is accomplished in several burning stages, with cooling between stages. Inasmuch as T.C.R. catalyst burns quite rapidly, the average regeneration temperature is maintained in the range of 800° to 1,000° F., which is approximately 200° F. lower than the comparable temperatures in a T.C.C. kiln.

Reactor . . . The reactor for a 15,000-bbl. per day T.C.R. unit is approximately 11 ft. in diameter, and it is designed to operate at a pressure of 175 psig. The naphtha and recycle-gas feed enter the center of the reactor and flow upward and downward to suitable vapor-disengaging sections. The two vapor streams which leave the reactor are combined before they enter the heat-exchange system.

The catalyst flows into the reactor through a pressure-lock system. The operations of filling, pressuring, emptying, and depressuring are controlled by a cycle timer which operates on a 10-minute cycle. The valves are 8-in. plug cocks which are equipped with stellited plugs and seats with special lubrication grooving.

Spent catalyst is purged in the bottom of the reactor; and, after it has left the reactor, it is transferred to a bucket elevator through a depressuring leg.

Since the heat content of the reactor effluent is large, an efficient heat-exchange system is essential to the economical functioning of the process. Fortunately the reactor effluent material is very stable, and it is possible to heat-exchange this stream directly without quenching. This insures the maximum availability of high-temperature level heat to the extent that approximately 60 per cent of the total heat removed from the reactor effluent serves to preheat the reactor input materials, and an additional 10 per cent is used to generate steam.

To avoid thermal cracking in the naphtha heater, the outlet temperature is limited to 900° F. maximum, and the furnace is designed for a high heat input rate to the tubes near the outlet in order to reduce time temperature effects.

Cracking minimized . . . Although the recycle gas contains about 1 per cent of pentane and heavier hydrocarbons, it is estimated that no significant cracking of this material will occur at temperatures below 1,200° F. Nevertheless, as an extra precaution, the recycle-gas heater is designed to minimize cracking. In addition, this heater is designed for a low pressure drop, viz., 15 psi., to maintain compression requirements at a minimum. Since the recycle gas enters this heater at a comparatively high temperature (about 800° F.), only radiant surface is used. For heat economy, the convection section of this heater is designed as a steam-generating unit and is tied in with the same steam drum which serves the kiln. This combination of features maintains the amount of surface required for heating the recycle gas to a minimum, and thus makes it possible to achieve a low pressure drop while thermal cracking effects are reduced to a minimum. The total heat absorbed by the recycle gas and naphtha in the heat-exchanger system exceeds that absorbed in the furnaces by about 20 per cent.

The total pressure drop through a T.C.R. system which operates at a pressure of 175 psig. reactor pressure is approximately 70 psi. For this condition, typical pressures at several points in the system are as follows: recycle-gas compressor, 210 psig.; reactor inlet, 185 psig.; reactor outlet, 175 psig.; and recycle-gas compressor suction, 140 psig. Because the recycle gas is circulated in large quantities, and because it has a low molecular weight, this system offers an ideal application for a centrifugal gas compressor. It is proposed, therefore, in plants with a capacity of 2,000 bbl. per stream day, or higher, to install a single centrifugal recycle-gas compressor which will be driven by a condensing turbine.

Absorber operation . . . The absorber operates at a pressure of 200 psig., and it is designed to recover substantially all of the pentane and heavier components and about 90 per cent of the butanes from the "off" gas. Although this recovery arrangement necessitates the recycling of a small amount of C_4+ material back through the reaction system, it has been established that this design is more economical than an independent absorption and stripping system.

This process is licensed by Socony-Vacuum Oil Co.

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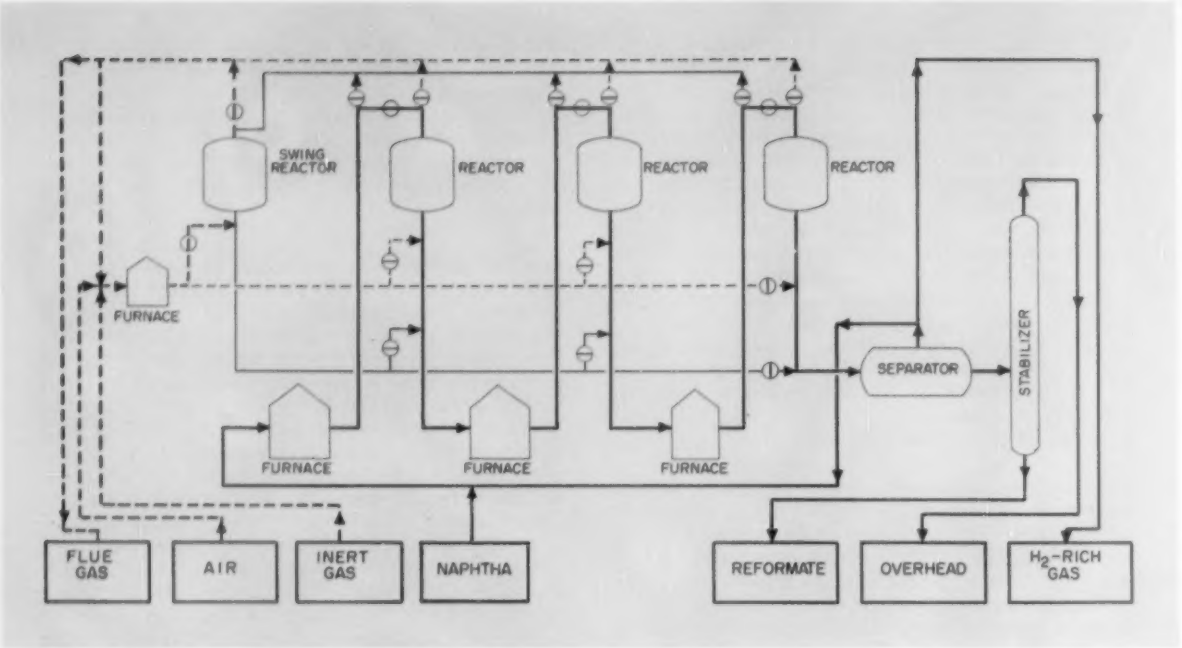


Ultraforming

ULTRAFORMING is a catalytic reforming process developed to take advantage of the higher yields and octane numbers offered by operation at low pressures. The process uses an improved platinum catalyst in fixed beds. These beds are regenerated by a novel technique that completely restores the catalyst to initial activity. The process favors conversion of paraffins to aromatics and thus produces high yields of aromatics and hydrogen. Twelve units with total capacity of 127,000 bbl. per day have been announced; four of these are now in operation.

Process description . . . A flow diagram of the Ultraforming process is shown in the figure. The swing reactor makes it possible to regenerate without interrupting reforming operations. As shown, catalyst in the swing reactor is being regenerated while naphtha is being processed in the other three.

Naphtha charge and hydrogen-rich recycle gas are heated in a furnace to reactor-inlet temperature and are then passed through a series of reactors. The predominant reactions are endothermic and cause a temperature drop across each reactor; furnaces between the reactors reheat the mixture. Effluent is condensed and separated into a liquid stream and a hydrogen-rich gas. The liquid is stabilized to the desired vapor pressure and withdrawn as finished reformate. Part of the gas is recycled; the rest can be used as a source of hydrogen for other processes or as fuel.

When catalyst activity in a reactor declines, that reactor is temporarily isolated from the naphtha-processing system and is replaced by the swing reactor. Naphtha processing continues while catalyst in the isolated reactor is regenerated with air and inert gas. After regeneration, the reactor is placed back on stream and the swing reactor is held in readiness until another reactor needs regeneration.

Operating conditions . . . Ultraforming is usually carried out at a pressure of 200-300 psi. and a reactor-inlet temperature of 900°-950° F. Hydrogen recycle rate, space velocity, and regeneration frequency are adjusted to the particular characteristics of the charge and to the product desired. With some installations, it may be economic to eliminate the swing reactor and to shut down the unit for regeneration.

Advantages of low pressure . . . Low-pressure operation is made possible by the Ultraforming regeneration technique. It offers four major advantages over conventional platinum-catalyst operation: (1) higher octane numbers, (2) higher gasoline yields, (3) higher effective catalyst activity and yield maintenance, and (4) greater flexibility. Low pressure also gives higher yields of aromatics and byproduct hydrogen. Some of these advantages are illustrated for a Mid-Continent naphtha by comparing Ultraforming 300-psi. operation with conventional 500-psi. operation:

At constant temperature and space velocity:	Ultra-forming	Conventional platinum reforming
Octane number, research, clear	95	91
Yield at constant octane (95 research, clear):		
10-lb. gasoline, vol. per cent	93	87
Aromatics, vol. per cent	47	44
Hydrogen, std. cu. ft./bbl.	1,150	930

"... process permits wide range of operating conditions and widely different charging stocks."

A plant of given capacity operating at low pressure can therefore produce gasoline of much higher octane. Moreover, at the same octane level, a plant operating at low pressure can produce higher yields of gasoline, aromatics, and hydrogen, and can either process more naphtha or operate with less catalyst.

Because Ultraforming regeneration fully restores catalyst activity, and because Ultraforming catalyst can be regenerated many times, the process permits a wide range of operating conditions, recovery from operating upsets, and the use of charge stocks varying widely in character. If excessive coke forms on the catalyst for any reason, the catalyst can be regenerated completely to restore operations to normal.

Yields . . . Ultraforming yields from Gulf Coast, Mid-Continent, and Arkansas naphthas at 300 psi. are shown in Table 1. Gulf Coast naphtha, containing 55 per cent naphthenes, produces more than 93 per cent of 10-lb. gasoline at the 100-octane level. Mid-Continent naphtha, containing 41 per cent naphthenes, gives 93 per cent of 95-octane product. Highly paraffinic Arkansas naphtha with only 15 per cent naphthenes, yields more than 85 per cent of 90-octane gasoline.

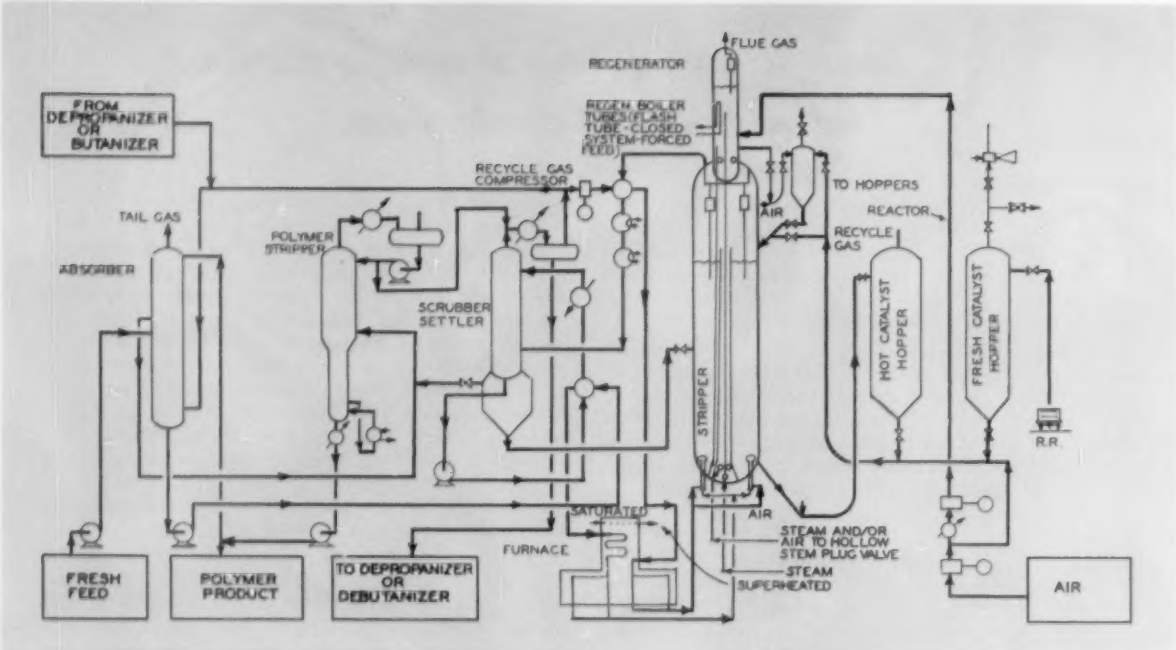
Catalyst . . . Results with the highly paraffinic naphtha demonstrate the unusual effectiveness of Ultraforming with even the least-favorable charge stock. This arises from the nature of the Ultraforming catalyst. Most platinum catalysts have good activity for conversion of naphthenes to aromatics. Even total conversion of naphthenes to aromatics, however, would not be sufficient to produce the high-octane motor fuels now appearing on the market and projected for the future. A good reforming catalyst must also convert paraffins to aromatics. The ability of Ultraforming catalyst to do so makes possible the production of high-octane reformates in high yield from even low-naphthene, high-paraffin feed stocks. The excellence of Ultraforming catalyst for aromatization of paraffins also makes the process attractive for producing aromatic concentrates from selected fractions of virgin naphthas.

Extensive studies show that the life of Ultraforming catalyst may be well above 100 bbl. of feed per pound of catalyst. The replacement cost is about $4.00 per pound, after receiving credit for platinum in used catalyst. For operations at 300 psi., catalyst cost should therefore be less than 4 cents per barrel—no more than that of catalytic cracking. American Cyanamid Co. cooperated in developing Ultraforming catalyst and now supplies it.

This process is licensed by Standard Oil Co. (Indiana).

TABLE 1—ULTRAFORMING YIELDS

Charge naphtha:						
A.S.T.M. distillation, °F.:	Gulf Coast		Mid-Continent		Arkansas	
Initial	202		206		149	
10 per cent	250		237		172	
50 per cent	305		274		244	
90 per cent	356		324		322	
End point	394		361		377	
Composition, volume per cent:						
Paraffins	26		50		77	
Naphthenes	55		41		15	
Aromatics	19		9		8	
Octane number, research, clear	59		44		45	
Products:						
C_5+ reformate:						
Octane number, research, clear	90	100	85	95	85	90
Yield, volume per cent	91.8	83.8	89.8	82.8	84.5	80.0
Reid vapor pressure	2.0	3.3	2.4	2.8	5.4	6.0
Butanes, volume per cent	2.7	6.2	3.1	5.5	7.1	9.3
Dry gas, weight per cent	3.4	7.2	4.8	8.4	7.5	9.8
Hydrogen, s.c.f./bbl.	900	1,100	970	1,150	540	590
10-lb. gasoline:						
Octane number, research, clear	90	100	85	95	85	90
Yield, volume per cent	105.7	93.2	103.1	93.3	91.8	85.7



Orthoforming

THE Orthoforming process is a variation of fluid Hydroforming. Its design stems from the commercial success of the Orthoflow type of fluid catalytic cracking developed by M. W. Kellogg Co., licensors.

The process employs a molybdena-alumina catalyst in microsphere form. It differs from the original "side by side" version of fluid Hydroforming, also licensed by Kellogg, in superimposing the regenerator directly over the reactor in a single vessel. This simplified design reduces construction costs, improves heat economy and promotes dependability, flexibility, and safety of operation.

Catalyst flow . . . By eliminating external catalyst transfer lines, the Orthoforming design confines the high-pressure, high hydrogen-gas flow entirely within the reactor-regenerator vessel. With catalyst carrier lines immersed in the hot catalyst bed, heat loss is confined to that from the vessel alone. The straightline flow of catalyst cuts turbulence and transfer-line erosion.

Spent catalyst flows from the top of the reactor bed, into the central stripper which has a high ratio of length to diameter. This shape plus its location inside the reactor gives the stripper a high efficiency for removal of entrained product, absorbed hydrocarbons, and chemisorbed hydrogen from the spent catalyst.

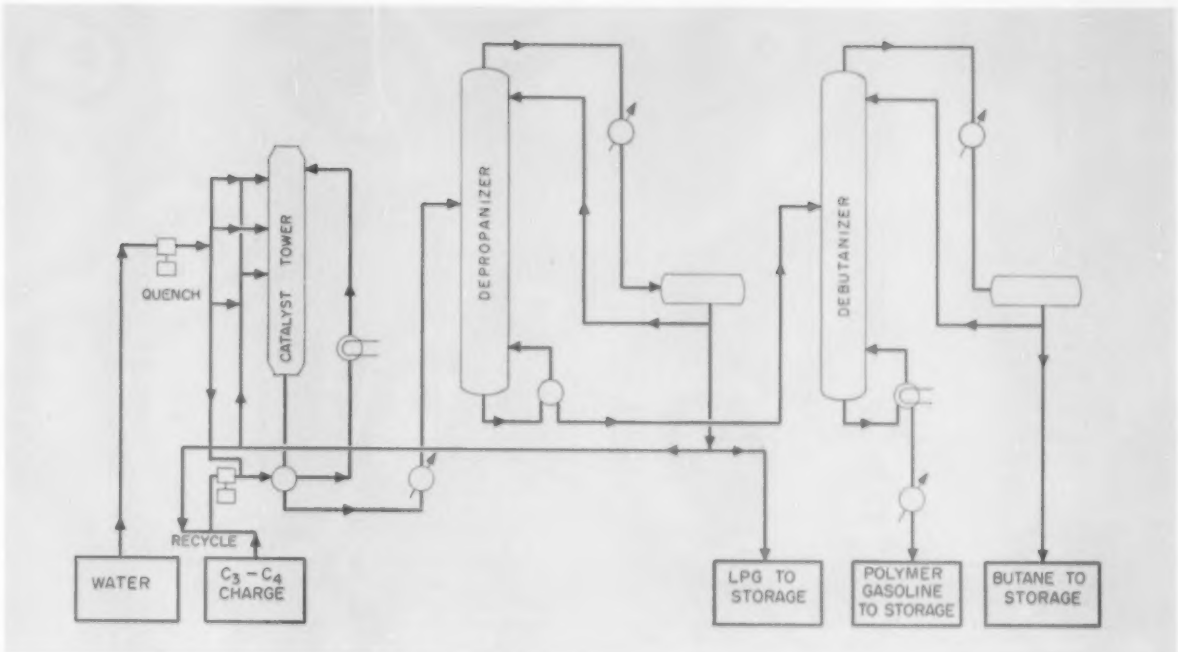
Stripped catalyst is lifted straight upward to the regenerator through the spent catalyst riser. Flow is controlled by a hollow-stem plug valve. Regenerated catalyst returns to the bottom of the reactor through a straight standpipe. This flow is controlled by a solid-stem plug valve.

The fluid Hydroforming process provides efficient contacting of catalyst with hydrocarbons and air, for isothermal reaction and regeneration. During extended operating periods, high yield can be maintained by controlling catalyst decline with continuous or periodic addition of fresh catalyst. Continuous regeneration keeps catalyst at top activity, permitting the refiner a wide choice of feed composition and boiling range.

High carbon yield resulting from high-severity or poor-quality feed can be dealt with successfully. This allows the reforming of thermally cracked, high sulfur stocks with a high end point which cannot be processed successfully by some other reforming techniques. Naphthas comprising up to 15 per cent of cracked material can be reformed. Since the feed is brought to desired reforming temperature by contact with hot regenerated catalyst, a low feed preheat is required. This eliminates precracking in the furnace coil.

Operating data . . . Yield and product inspection data from commercial operation in a fluid Hydroformer have proved to be comparable with earlier pilot-plant predictions. The process shows an extremely high-octane potential, producing a debutanized reformate with a 95 research octane rating, clear. High flexibility is demonstrated in commercial operations ranging from 55 to 130 per cent of design capacity.

Operating conditions may vary over the following approximate ranges: Reactor pressure 200-500 psi., reactor temperature 900°-950° F., regenerator pressure 210-510 psi., regenerator temperature 1,000°-1,100° F. Space velocity can range from 0.30 to 0.80 W/hr./W and catalyst to oil ratio from 0.25 to 1.00. Hydrogen recycle is possible over a wide variation of 4,000-8,000 cu. ft. per barrel of feed.



Phosphoric Acid Polymerization

THE great expansion of the petrochemical industry has added tremendously to the uses of U.O.P. solid phosphoric acid catalyst. This is an important polymerization and alkylation agent for the production of valuable chemicals and chemical builders. At the same time the excess of propylene and butylenes in refineries has required a great increase in capacity for polymerization to motor fuel.

Chamber units . . . Recent advances in engineering have reduced the capital costs and increased the efficiency of the chamber-type polymerization units such that there are now more chamber-type units being designed than the "reactor" or tubular type of unit. It is these chamber-type units that are now being widely used in the petrochemical field.

The products now being produced or under consideration for these units are tetramer, cumene, ethyl benzene, secondary butyl benzene, diisopropyl benzene, and C_6-C_9-C_{15} olefins for the production of alcohols and sulfonates.

Products . . . The flow chart shows a polymerization unit for C_3-C_4 motor polymer. A rerun column is added when producing tetramer or alkyl aromatics such as cumene on this unit. Tetramer is the basic material for the alkyl aryl sulfonate type of detergent and cumene is now used as a basic material for the production of phenol and acetone.

Yields of the above chemicals normally correspond to 92-96 weight per cent conversion of the olefin charged. Properties of some of the products are shown in Table 1.

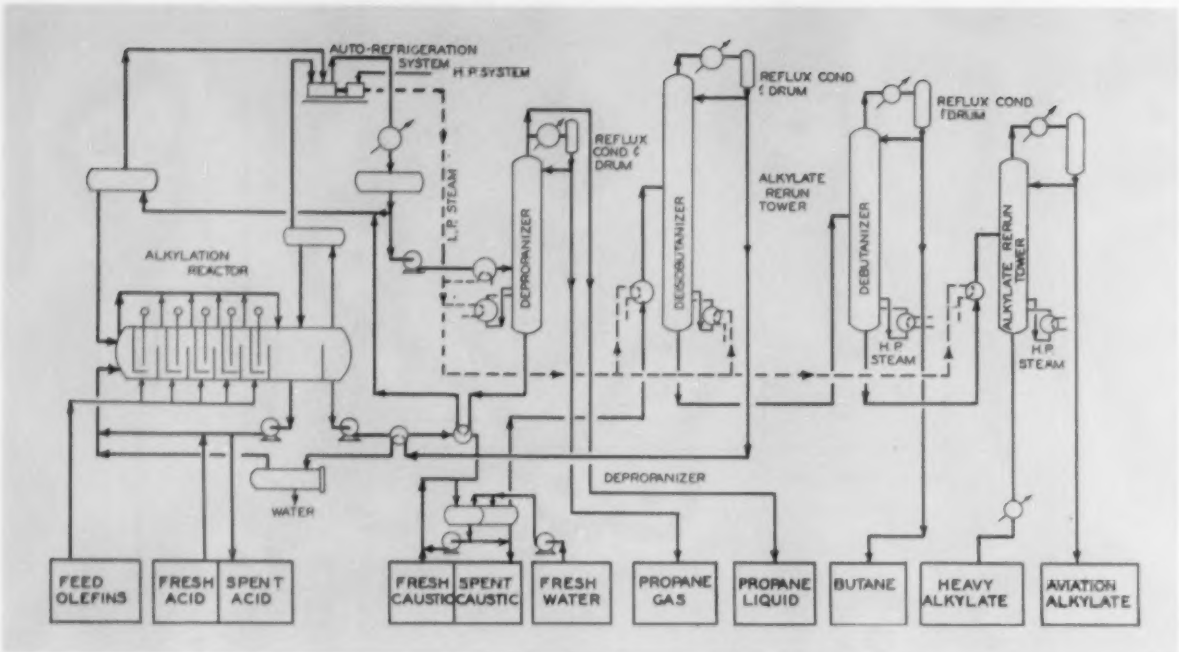
TABLE 1—PROPERTIES OF PRODUCTS

	C_3 Motor Polymer	C_3-C_4 Polymer	Tetramer	Cumene
R.v.p.	12.0	9.2	...	...
Gravity, °A.P.I.	61.4	66.1	51.0	
A.S.T.M. Engler dist.:				A.S.T.M. aromatic dist.
I.b.p.	103	96	353	301
5 per cent	194	130	...	302
10 per cent	228	149	361	302
30 per cent	266	201	...	302.5
50 per cent	282	228	371	303
70 per cent	302	263	...	303
90 per cent	378	348	397	303
E.p.	421	422	450	°304
F-1 octane + 3 ml. TEL	99.5	99.6	...	...

°Dry point.

In the production of tetramer, there are also produced motor polymer and tetramer bottoms. The motor polymer yield is 1-25 liquid volume per cent and bottoms yield is 2-4 liquid volume per cent of the total polymer produced. These percentages vary because of the various tetramer specifications.

This process is licensed by Universal Oil Products Co.



Sulfuric Acid Alkylation

AS the high-compression engine high-octane trend continues, alkylation is gaining considerable attention as a process for producing high-octane blending stocks for motor gasoline.

Basically, sulfuric acid alkylation is a low-temperature process which employs a concentrated sulfuric acid catalyst to combine olefins such as propylene, butylenes, or pentenes with isobutane.

The process has many advantages over catalytic polymerization because:

1. Isobutane as well as olefins are converted, resulting in an increased product yield.
2. Alkylate is essentially free of gas-forming materials so that additives are not required.
3. Alkylate has a higher tetraethyl lead response.
4. Performance in supercharged engines is superior to catalytic polymerization gasoline.

In Cascade alkylation units, developed and licensed by M. W. Kellogg Co., isobutane is reacted with olefins to form saturated isoparaffins in the presence of sulfuric acid catalyst. Propylene, butylene, and amylene olefins are converted either individually or in mixtures, and are combined with the isobutane in a highly agitated emulsion in which the continuous phase is sulfuric acid catalyst.

Component analysis determined by true boiling point tests of two typical alkylate samples, Table 1, illustrates the type and quality of compounds formed from various feed stocks.

Operating features . . . The diagram above illustrates the schematic flow through a typical alkylation unit, which has resulted in lower plant investment, improved operating cost, and superior-quality alkylate.

Olefin-bearing liquid feed is cooled to about 35° to 45° F. and contacted with an excess quantity of isobutane and acid catalyst in the reactor at 5 to 15 psig. The olefin feed is split into equal streams and charged to each reaction zone of the Cascade system. Isobutane-rich recycle and refrigerant streams are introduced into the first reaction zone and pass in series flow through successive zones to provide the necessary excess isobutane.

Reaction products, excess isobutane, and other diluents in the feed remaining in the liquid phase are separated from the acid in the settling zone and charged to fractionation equipment for separation of isobutane recycle and normal butane from the alkylate product. The heavy polymers produced are separated from the desirable alkylate in the rerun tower; isobutane is returned to the head reaction zone of the reactor, and normal butane withdrawn to product storage.

Refrigerant vapor resulting from removal of heat of reaction is compressed, condensed and the liquid returned to the head reaction zone. This refrigerant is predominantly isobutane; however, its propane content is higher than elsewhere in the process. A portion of this refrigerant is diverted to the depropanizer tower for removal of propane from the system.

Sulfuric acid catalyst is recirculated through the reactor to stabilize the acid strength and as contaminants build up a portion of the circulating acid is withdrawn and replaced by high purity sulfuric acid.

Acidic material entrained in the effluent hydrocarbons is removed by caustic and water treatment.

Reactor design . . . The Kellogg Cascade reactor incorporates several features conducive to proper processing conditions for economic production of high quality alkylate, including:

1. The internal mixer and the undershot or L-baffle

between compartments, which maintain proper fluid flow conditions for efficient olefin and isobutane contact with the sulfuric acid catalyst for maximum yield of alkylate and minimizing undesirable byproducts.

2. Heat-exchange surface and auxiliary refrigerants are not required since the heat of reaction is removed by autorefrigeration in vaporizing a portion of the hydrocarbon stream at the location of reaction, thus promoting isothermal operation.

3. Series flow of isobutane recycle and acid catalyst, and parallel flow of olefin feed create optimum reaction conditions of high isobutane concentration and high isobutane-olefin ratio, with a minimum flow of external isobutane recycle.

4. Multicontactors with settling zones incorporated in the same vessel reduce the quantity of steel, etc., required and result in a lower installation cost. These details are shown in the accompanying sketch which shows the reactor cross-section.

Yield . . . Yield of alkylate from several typical feed streams are compared in Table 2 with respect to isobutane and acid consumption, along with typical octane ratings of alkylate rerun to aviation gasoline specifications. Higher acid consumption, lower aviation alkylate yields, and lower octane values are typical for operation where low isobutane-olefin ratios or low isobutane concentration are used in the reactor. Higher values are representative of operation where high isobutane concentration conditions are maintained for maximum quality product.

TABLE 1—COMPONENTIAL BREAKDOWNS OF TOTAL ALKYLATES

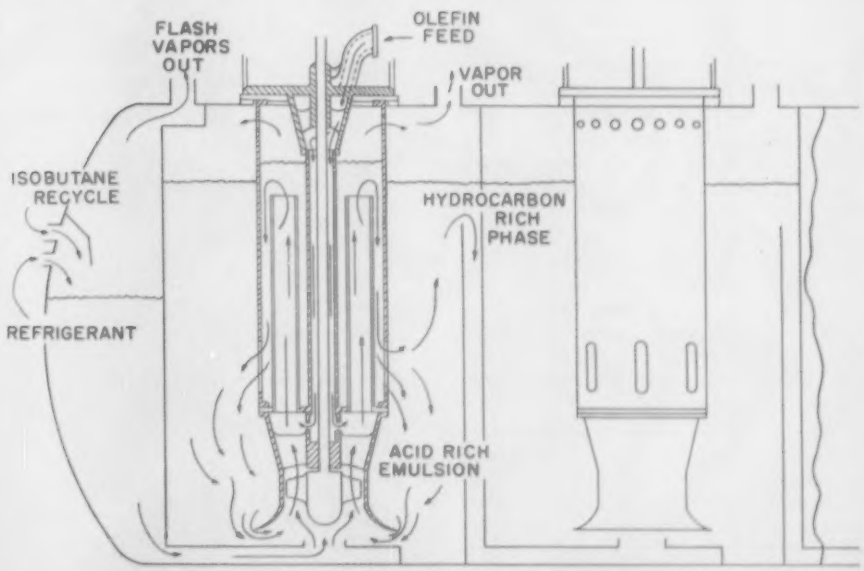
Components—	Boiling point, °F.	F-4 index No. (4.0 cc. TEL)	LV%*	LV%†
2,3-Dimethyl butane	128	205	5.9	4.2
2,2-Dimethyl pentane	175	143		
2,4-Dimethyl pentane	177	83	4.3	3.3
3,3 and 2,3-Dimethyl pentane	194	140	9.5	2.2
2,2,4-Trimethyl pentane	211	154	31.9	30.4
Dimethyl hexane	233	44	1.1	5.9
2,3,3-Trimethyl pentane	230	225		
2,3,4-Trimethyl pentane	236	193	32.4	37.7
Isononanes	265-290		3.2	5.2
Isodecanes and heavier	295		11.7	11.1
Total			100.0	100.0

Types of alkylate produced: *25 per cent C_3, 75 per cent C_4. †3.5 per cent C_3, 90 per cent C_4, 6.5 per cent C_5.

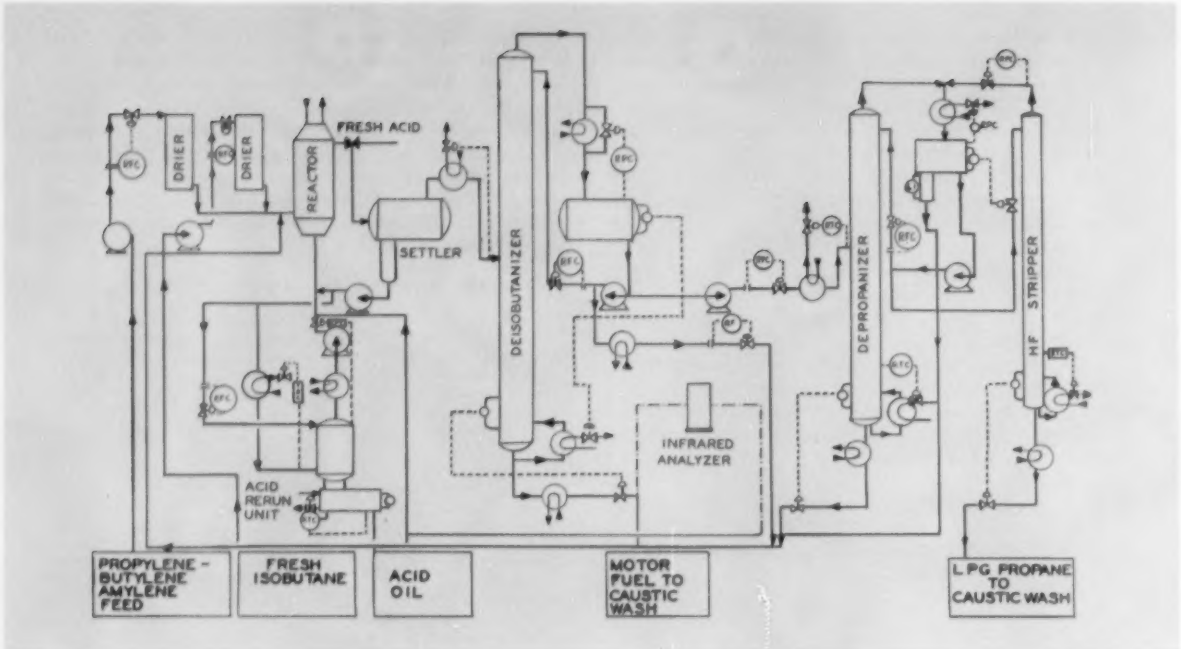
TABLE 2—TYPICAL ALKYLATION YIELD DATA

Olefin feed type—	Propylene	Propylene-† butylene‡	Butylene	Amylene
Yield (volume per cent on olefins):*				
Total alkylate	178	174	172	160
Aviation alkylate (338° F. e.p.)	150-160	156-162	153-165	140-149
Isobutane consumption: Gal. iC_4 per gal. olefin (neglect fractionation loss)	1.275	1.17	1.106	0.965
Acid consumption (average): Pounds 98 per cent H_2SO_4 per gallon total alkylate	1.8-2.0	1.0-1.3	0.4-0.6	1.0
Aviation alkylate quality:				
Research Oct. No., clear	89-92	93-95	94-97	92-93
1.5 cc. TEL	100.5-102.5	102.5-104.5	103-105.5	102-103
A.S.T.M. Oct. No., clear	87-90	91-93	92-95	90-92
F-3 or 1-C Oct. No., 4.6 cc. TEL	103-105	105-107	107-109	105-107
F-3 or 1-C performance No., 4.6 cc. TEL	110-117	119-124	124-132	116-123
F-4 or 3-C performance No., 4.6 cc. TEL	132-142	145-153	150-162	140-148

*True alkylate—corrected for components in feed. †40 per cent. ‡60 per cent.



Details of the Kellogg Cascade alkylation reactor.



H F Alkylation Phillips

THE alkylation of isobutane with olefins such as propylenes, butylenes, or amylenes, using hydrofluoric acid as a catalyst, is a well-established process for producing high-octane-number blending components used in aviation gasoline and motor fuels. Until recently, due to government regulation, most alkylate was utilized in aviation-gasoline rather than motor-fuel blending. With these restrictions removed, and with the ever-increasing demand for higher octane and quality, more and more alkylate will be used in motor fuel.

Essential features of the Perco HF alkylation process are shown in the flow diagram. Liquid feed containing olefins and isobutane is passed through bauxite driers and fed into the lower section of the reactor, while the liquid hydrofluoric acid enters the reactor through a recycle line connected to the bottom of the reactor.

The alkylation reaction is completed by intimate contacting, after which the hydrocarbon material and the recycle acid flow to the settler where a two-phase separation occurs. The acid phase is recycled back to the reactor. The hydrocarbon phase is fed to the fractionating section where the recycle isobutane is separated from motor-fuel alkylate.

The reactor effluent is water-cooled to a temperature of 85° to 100° F., depending upon seasonal changes in cooling-water temperature. Variation within this 15° F. temperature range does not have an appreciable effect on either product quality or operating cost. The acid-hydrocarbon ratio of the reactor feed is not critical and ranges from 0.2:1 to 1:1. For the purpose of product-quality control, an excess of isobutane is recycled to the reactor with the olefin. External isobutane-to-olefin ratios from 2:1 to 20:1 have been used but for motor-fuel production the optimum will be approximately 5:1.

As an auxiliary to the operation, an acid rerun unit is provided, where the hydrofluoric acid catalyst is continuously purified by the fractionation of a small portion of the circulating acid stream. The acid-soluble oil production is so small that it can be easily disposed of in furnace fuel without further neutralization.

Specific attention should be given to the simplicity of this new design. It should be noted that no intermediate charge pumps, surge tanks, or stripping towers are employed between the outside storage charge pumps and the deisobutanizer tower. The present acid-hydro-

TABLE 1—TYPICAL OPERATION OF HF ALKYLATION

(Based on 100 bbl. per day total feed)

	Bbl.
Charge to unit:	
C_4 fraction from cat cracker:	
Propane	0.9
Propylene	0.9
Butylenes	32.5
Isobutane	40.2
n-Butane	25.5
Total unit feed	100.0
Yields from unit:	
Propane	0.9
Isobutane	1.1
n-Butane	25.5
Alkylate	56.8
Total yield	84.3

". . . 1.7 bbl. of motor-fuel alkylate is produced for each barrel of olefin charged."

carbon reactor is not equipped for mechanical agitation and is essentially a shell-and-tube heat exchanger. In addition to simplifying the unit operation, these revisions considerably reduce both the investment requirements and the operating expense; only two men are required to operate a unit of this design.

Caustic washing is the only treatment employed on motor-fuel alkylate, thus eliminating the former expense of catalytic defluorination. An infrared analyzer records continuously the isobutane content of the recycle isobutane and motor fuel alkylate. Use of the infrared analyzer results in considerable reduction of isobutane losses to motor fuel and improves alkylate quality by maintaining high-purity isobutane recycle.

The infrared analyzer also reduces the number of laboratory technicians required for efficient control, as compared to units where this type instrument is not employed.

As shown in Table 1, the C_4 fraction of the gas-plant product from catalytic cracking normally has an isobutane-butylene ratio that is approximately balanced for alkylation-unit feed stock. The production of isobutane in a catalytic cracking operation eliminates the necessity of purchasing large quantities of this charge component from an outside source, as was formerly the case when the olefin feed stock was obtained from thermal cracking operations.

It can be seen in Table 1 that 1.7 bbl. of motor-fuel alkylate is produced for each barrel of olefin charged. This compares with 0.7 bbl. of motor-fuel polymer produced per barrel of olefin charged to catalytic polymerization operations. The A.S.T.M. gum content of motor-fuel alkylate, shown in Table 2, is considerably lower than in motor-fuel polymer. The TEL susceptibility and motor-fuel blending value are also better for motor-fuel alkylate than for polymer.

The on-stream factor for the modernized Perco HF alkylation unit is approximately 98 per cent. Units are currently operated continuously and trouble-free for periods of 18 to 24 months between turnarounds. The safety records set by both operators and maintenance men on HF alkylation units of Perco design are as good as or better than the safety records of any other refining unit.

Table 3 shows the operating expenses of a modernized HF alkylation unit that is designed for motor-fuel production. It can be seen that HF alkylation is competitive with all other processes employed for conversion of olefins to motor fuel. The HF alkylation process has many advantages in motor-fuel production and should be seriously considered for installation in any refinery with crude processing facilities above 15,000 bbl. per day.

This process is licensed by Phillips Petroleum Co.

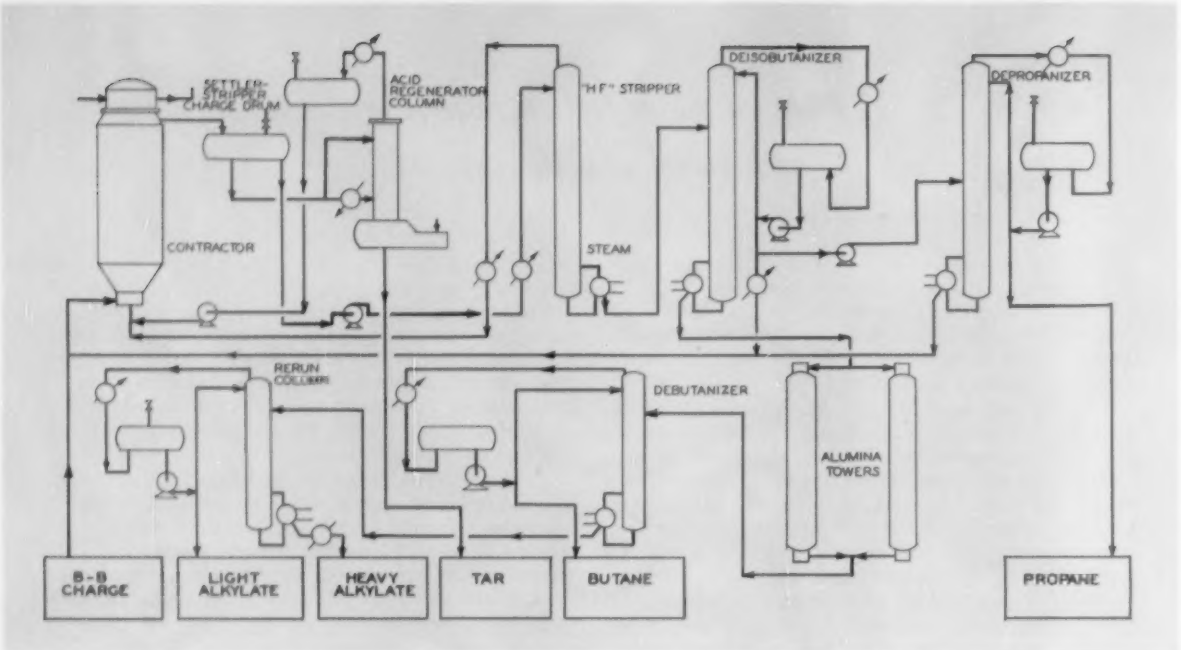
TABLE 2—TYPICAL PROPERTIES, DEBUTANIZED MOTOR-FUEL ALKYLATE

Gravity, °A.P.I.	68.8
A.S.T.M. distillation, °F.:	
I.b.p.	160
10 per cent evap.	199
20 per cent evap.	210
50 per cent evap.	224
90 per cent evap.	264
95 per cent evap.	336
End point	392
Color, Saybolt	30
Doctor test	Negative
Corrosion, 122° F.	Negative
A.S.T.M. gum, mg. per 100 ml.	0.4
A.S.T.M. research octane number:	
+0 ml. TEL	93.1
+1 ml. TEL	*100.8
+3 ml. TEL	†104.9

*Equivalent to A.S.T.M. research method rating of 0.036 ml. TEL in isooctane. †Equivalent to A.S.T.M. research method rating of 0.34 ml. TEL in isooctane.

TABLE 3—SUMMARY OF DIRECT OPERATING EXPENSE, 98 PER CENT STREAM FACTOR

	Dollars per bbl. alky.
Operating labor (2 men per shift)	0.0800
Supervision and laboratory	0.0800
Repair labor and materials	0.1600
Utilities (per bbl. of alkylate):	
Steam, 7.5 lb. at 18 cents per M. lb.	0.0014
Fuel, 1.05 M.M. per B.t.u. at 10 cents per M.M. B.t.u.	0.1050
Circ. water, 67½ gal. at 9 cents per M. gal.	0.0061
Electricity, 1.9890 kw.-hr. at $0.0057 per kw.-hr.	0.0115
Chemicals (per bbl. of alkylate):	
0.1430 lb. caustic at 3½ cents per lb.	0.0050
0.2700 lb. acid at 19 cents per lb.	0.0510
Miscellaneous	0.0100
Total	0.5100



H F Alkylation U.O.P.

THE HF alkylation process is a catalytic process for reacting isobutane with propylene, butylenes, amylenes, or higher-boiling olefins or mixtures of olefins to form a highly branched paraffinic product of excellent antiknock properties and TEL susceptibility for use as a blending component in aviation gasoline or motor fuel. Butylenes or butylenes plus propylene are the most common olefin charging stocks.

The process is especially applicable in a refinery where additional isobutane charge and low-boiling materials required for gasoline vapor pressure can be obtained at low cost from sources other than cracking, thereby permitting the use of all of the low-boiling olefins as charging stock for the production of alkylate. Twenty-eight HF alkylation plants were put into operation during World War II for the production of aviation gasoline and later operation of some of the units in manufacture of motor fuel has demonstrated that such operation is feasible and competitive with other methods of processing refinery olefins.

The HF alkylation plant as shown by the simplified flow diagram, consists essentially of a reactor, an effluent settler, a fractionation section, catalytic defluorinators, and a catalyst regenerator. In motor-fuel production the rerun column and in specific instances the debutanizer can be eliminated thereby reducing costs.

Improvements have been made in the plant design resulting in lower capital and operating costs, less catalyst inventory, and simplified plant arrangement and control. The contactor has been reduced in size, catalyst circulation pumps have been eliminated, the regenerator has been simplified with provisions for improving the purity of the regenerated HF, and the fractionation section has been rearranged to reduced the utility requirements.

The raw-material requirements, yields, and product quality in alkylation with butylenes and propylene are shown below:

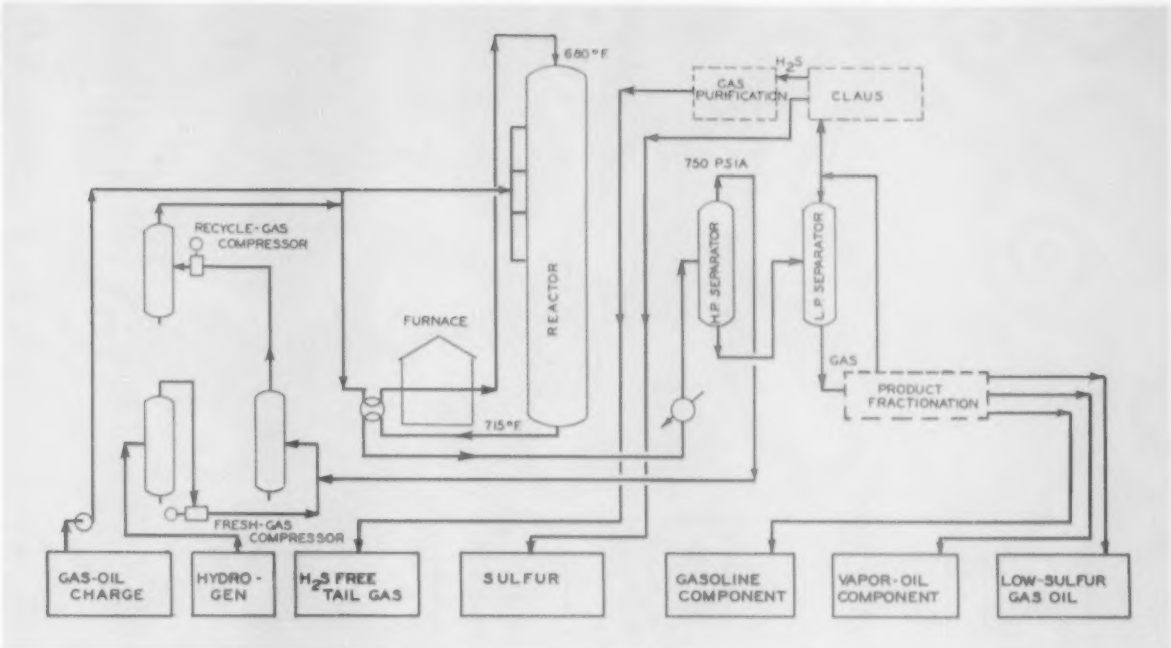
	Vol./Vol. olefin		F-1 ON		F-2 ON	
	Isobutane	Alkylate	Clear	+3cc. TEL	Clear	+3cc. TEL
Butylenes	1.16	172	93-95+	100+	92-94	100+
Propylene	1.50	175	90-91	98+	89-90	98+

Analytical data and antiknock rating interrelationship for a rerun butylene alkylate are as follows:

Gravity, °A.P.I.	70.7
Reid vapor pressure, psi.	3.5
Isopentane content, volume per cent	4.3
Volume per cent of total alkylate	94.7
Engler distillation:	
I.b.p., °F.	148
10 per cent	197
50 per cent	218
90 per cent	226
E.p.	247
Antiknock ratings:	
F-1 clear, octane number	95.2
F-1-3. Oml. TEL/gal., octane number	104.6
F-2 clear	93.5
F-3-4.6 ml. TEL/gal., octane number	106.7
F-3-4.6 ml. TEL/gal., perf. number	131.6
F-4-4.6 ml. TEL/gal., Iso C_5 + ml. TEL	3.64
F-4-4.6 ml. TEL/gal., perf. number	150.6

Optimum processing arrangement and conditions must be determined for each installation.

This process is licensed by Universal Oil Products Co.



Hydrodesulfurization

THE Shell hydrodesulfurization process is designed to remove sulfur from petroleum fractions by catalytic means, using an outside source of hydrogen. Unique features of the process are its use of low hydrogen recycle rates and treatment of the oil largely in the liquid phase.

Liquid charge, together with hydrogen, trickles downward through a fixed bed of cobalt-molybdenum-alumina catalyst. Through this feature, it has come to be commonly known as the "trickle process." As in other hydrodesulfurization processes, sulfur removal is achieved by replacement of sulfur by hydrogen, with simultaneous formation of hydrogen sulfide.

Hydrogen-rich gas from catalytic reforming operations can be readily used in this process, since normal dilution by hydrogen sulfide or methane do not affect the efficiency of the process significantly. Accordingly, no hydrogen sulfide removal is necessary on the recycle stream. Hydrogen consumption will range from 50 cu. ft. per pound of sulfur removed for straightrun stocks, to 75 for catalytic cycle stocks.

Basis for process . . . In developing the new technique, scientists of the Royal Dutch-Shell group at the Amsterdam laboratories noted that desulfurization was most complete at hydrogen recycle rates corresponding to the break point between trickle and vapor-phase operation. They found further that the reduction in sulfur removal was very small when hydrogen recycle rates were reduced from the range of 5,000 to 10,000 std. cu. ft. per bbl., corresponding to vapor-phase operation, to the range of 250 to 1,500 std. cu. ft. per bbl. in trickle operation.

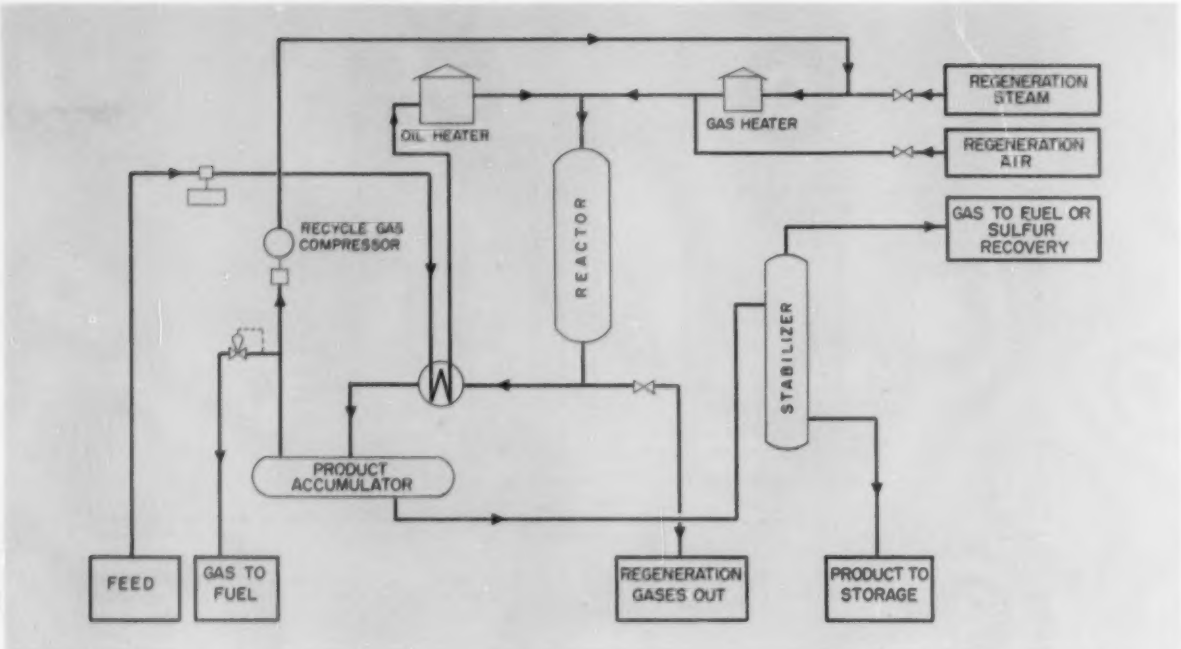
The commercial advantage of the trickle operation lay in the substantial savings in capital (compressor, furnace, exchangers, etc.) and operating costs. Trickle operation also permits the treating of higher-boiling fractions since they need not be vaporized.

Process flow . . . The process flow is illustrated schematically in Fig. 1. Oil charge together with fresh and recycle hydrogen is preheated by exchange with reactor effluent and further heated in a furnace before being charged to the reactor. The reactor may contain a number of catalyst beds, between which fresh charge can be injected to take up the heat produced by the exothermic hydrogenation reactions. The number of beds is determined by the sulfur content of the charge and the degree of desulfurization desired.

Reactor effluent is cooled and passes to the high-pressure separator where unreacted hydrogen is separated for recycle. In the low-pressure separator, the hydrogen sulfide and some of the light hydrocarbons are flashed off for delivery to the plant fuel system or to gas purification and sulfur-recovery facilities.

The process can be operated at pressures ranging from 300 to 750 psia., and temperatures of 660° to 730° F. When deep desulfurization (80 to 90 per cent sulfur removal) is desired, preferred operating conditions are 600 to 750 psia. and 690° to 720° F.

Other uses . . . Although developed primarily for sulfur reduction, Shell hydrodesulfurization also upgrades straightrun distillates to yield high-grade diesel fuels, lube stocks, and burning oils. It improves flashed distillates as catalytic cracking feed stocks, resulting in lower coke production and higher gasoline yield; the attending reduction of nitrogen compounds also permits a higher cracking catalyst activity.



Autofining

AUTOFINING is a process for the catalytic desulfurization of petroleum distillates, developed by British Petroleum Co., Ltd. Main feature of the process is that the hydrogen necessary for the conversion of sulfur to hydrogen sulfide is provided from the feed stock itself by controlled dehydrogenation of the naphthenes present. No external hydrogen manufacturing or byproduct hydrogen facilities are required.

Commercial units . . . The process can be applied to the desulfurization of all straightrun distillates up to 700° F. end point, aromatic extracts, and blends of straightrun and cracked distillates. Three commercial units are at present being operated by B.P.C. These are a 500-bbl. per stream day unit at Grangemouth, Scotland, which desulfurizes kerosine sulfur dioxide extract for use as a high-octane tractor-fuel component and two 3,500-bbl. per stream day units at Llandarcy, South Wales, and Aden. These latter units operate on a tractor-fuel blend and give products requiring no further treatment before marketing.

Process . . . A simplified flow diagram of the process is shown. The feed stock and recycle gases are heated to the reaction temperature and pass downward through the reactor. The reactor products, after heat exchange and cooling, flow to the product accumulator from which the recycle gas compressor takes suction. Any excess gas make is passed to fuel from the product accumulator. Liquid product from the accumulator passes to a flash tower stabilizer to remove hydrogen sulfide and for flash-point rectification. A light caustic wash may be given before the product passes to storage. When operating on feed stocks such as tractor fuel for which the product has to meet a color specification, the reactor effluent is passed through a waste-heat boiler and knockout tower to remove 1 to 2 per cent volume of heavy ends.

Operating variables . . . These are temperature, pressure, space velocity, and recycle rate. The usual operating temperature is in the range 750°-800° F. Space velocities of between 2 and 5 are normally employed depending on the degree of desulfurization required. The normal recycle rate is 2,000 standard cubic feet per barrel. In the current commercial autofining process a constant pressure in the range 100 to 200 psig. is usually employed. With this type of operation dehydrogenation produces more hydrogen than is required for desulfurization at the constant pressure employed and this excess gas is vented. Alternatively, equilibrium pressure operation can be employed. In this method of operation no hydrogen is vented from the system and the pressure builds up to an equilibrium value, usually in the range 200-500 psig. This procedure is advantageous when processing heavier feed stocks such as diesel oil.

Catalyst . . . The preferred catalyst is of the mixed cobalt and molybdenum oxides on alumina type and it can be readily regenerated with steam-air or inert gas-air mixtures when its activity is fully restored. It is not necessary to remove hydrogen sulfide from the recycle gas. Processing periods between regeneration depend on the distillation range of the feed stock and the space velocities employed. Generally with the lighter feed stocks such as straightrun naphthas and kerosines, re-

"Light straightrun feed stocks can be almost completely desulfurized at space velocities of 5 vol./vol./hour."

generation is only required at intervals in excess of 1,000 hours. With heavier feed stocks such as diesel oils the intervals are reduced to 200 to 400 hours.

Product recovery on autofining is very high, the major loss being that due to the removal of sulfur. Any losses due to the small gas yield and laydown of carbon on the catalyst are usually less than 0.1 per cent weight. A small increase in A.P.I. gravity usually results in a volume recovery of approximately 100 per cent.

Typical results from the autofining of a variety of feed stocks are given in Tables 1 and 2. The data given here are taken from commercial operation.

Applications . . . Straightrun feed stocks up to around 400° F. A.S.T.M. end point can be more or less completely desulfurized at space velocities of 5 vol./vol./hour (Table 1). Desulfurization is accompanied by an increase in clear octane number of between 2 and 3 numbers and a greatly improved lead response. An important application of the process, apart from the obvious one of motor-gasoline components, is the autofining of naphtha feed stocks for the production of petroleum spirits (Table 1).

Feed stocks in the kerosine distillation range (320°-500° F.) are also almost completely desulfurized by autofining under similar conditions to those used for naphtha feed stock. In addition to the elimination of sulfur the burning properties of the oil are improved (Table 1).

With feed stocks in the diesel-oil distillation range, e.g., 400°-660° F. A.S.T.M., approximately 50 per cent desulfurization is obtained over a process period of 200 hours at a space velocity of 2.0 vol./vol./hour. With these heavier feed stocks a small amount of light ends are formed and it is necessary to remove less than 1 per cent of the product for rectification of the flash point. The cetane number and pour point are unchanged on autofining. An improved catalyst for treating diesel oils under equilibrium conditions has been developed.

Data for the autofining of aromatic extracts and tractor fuel blends containing extract and straightrun naphtha (Table 2) are typical of commercial operations at Grangemouth and Llandarcy, respectively. In both cases autofining has replaced acid washing and both plants have operated very satisfactorily for a number of years. The catalyst from the 3,500-bbl. per stream day unit at Llandarcy when examined after 2 years use was found to have lost little or none of its desulfurizing activity and physical strength and was replaced for further use.

The Llandarcy unit operates at 100 psig. pressure and a space velocity of 3.0 vol./vol./hour on tractor-fuel feed stock, and incorporates a waste-steam boiler and knockout tower to improve the color of the products.

Utilities for this plant are:

150-lb. steam, lb./hour (net)	5,000
Cooling water, I.G./hour	20,000
Fuel, million B.t.u./hour	25
Electric power, kw.	10

TABLE 1 — AUTOFINING OF MIDDLE EAST STRAIGHTRUN LIGHT DISTILLATES

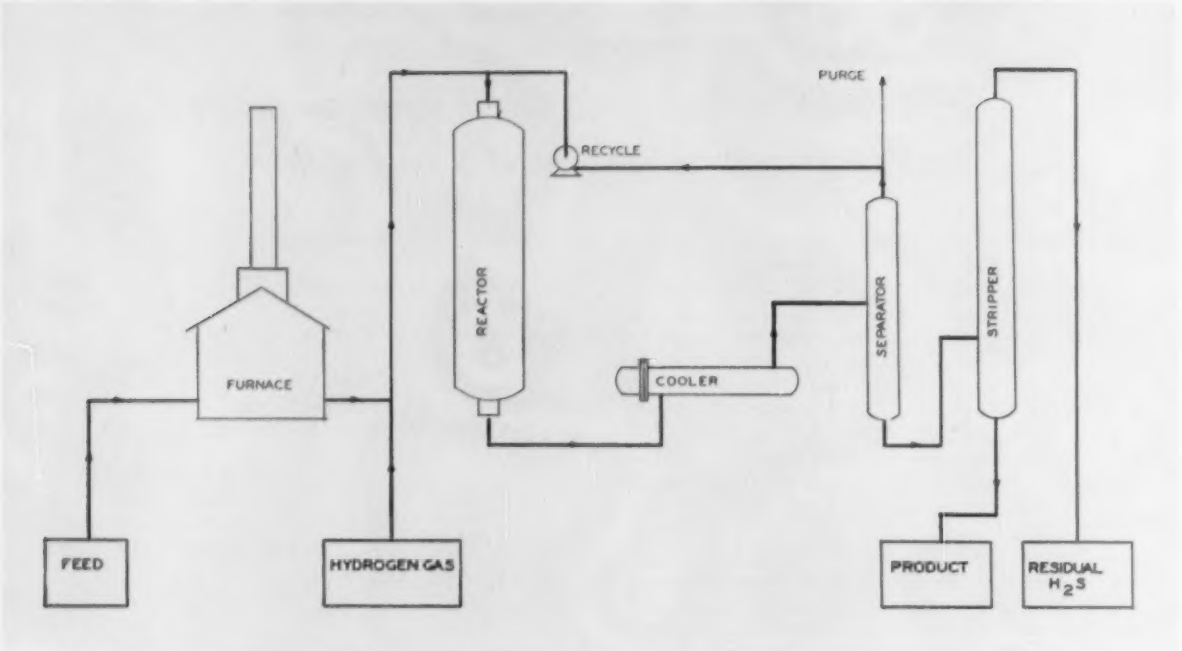
	Naphtha		Kerosine	
	Feed stock	Products	Feed stock	Products*
Gravity, °A.P.I.	49.9	49.9	46.8	47.0
A.S.T.M. distillation, °F.:				
I.b.p.	302	293	320	311
10 per cent	318	318	345	351
50 per cent	338	338	387	387
90 per cent	374	372	446	444
End point	408	412	478	477
Total sulfur, per cent wt.	0.143	0.003	0.27	0.004
Sulfur removal, per cent		97.9		98.5
Char value (†IP10-52T), mg./kg.			20	12
Color Saybolt			+25	+30

*Approximately 1 per cent volume bottoms removed in knockout tower. †Institute of Petroleum.

TABLE 2 — AUTOFINING OF MIDDLE EAST KEROSINE SULFUR DIOXIDE EXTRACT AND TRACTOR FUEL†

	Extract		Tractor fuel†	
	Feed stock	Product	Feed stock	Product*
Gravity, °A.P.I.	31.1	31.7	40.2	41.1
A.S.T.M. distillation, °F.:				
I.b.p.	327	311	309	298
10 per cent	347	347	336	329
50 per cent	388	383	383	381
90 per cent	486	483	460	453
End point	563	567	511	496
Total sulfur per cent wt.	1.04	0.45	0.645	0.106
Sulfur removal per cent		56.8		83.6
A.S.T.M. octane number (D357, motor method) without TEL addition	76	77	45.3	47.0
Color Saybolt			+10	+21
Copper-dish corrosion test at 212° F.			Pass	Pass

*Approximately 1.5 per cent volume bottoms removed in knockout tower. †Blend of kerosine sulfur dioxide extract and straightrun naphtha.



Hydrofining

THE Hydrofining process utilizes byproduct hydrogen from catalytic reforming to upgrade a wide variety of petroleum products and intermediate processing streams. It is a mild form of hydrotreating which produces volumetric yields of 100 per cent. While operating conditions vary widely depending on the feed stock and the desired degree of treating, they are not normally severe, ranging from 400° to 800° F. and 50 to 800 psig.

A Hydrofining unit affords continuous operation with relatively simple equipment comprising a feed preheat furnace, a fixed-bed reactor, gas-compression and separation facilities, and a stripper. In some mild operations, sufficient feed preheat can be obtained by exchange with effluent. Blocked operation is possible, and finished products require no rerunning.

This process will upgrade poor-quality stocks previously considered unattractive for processing. It entails no disposal problem of waste products, since the principal byproduct, hydrogen sulfide, can be readily converted to sulfur.

Naphtha treating . . . Virgin naphthas are being Hydrofined to reduce sulfur from 0.12 to 0.01 per cent or lower, giving leaded octane improvement up to 10 numbers. Sulfur reduction to as low as 1 p.p.m. has been demonstrated for platinum-catalyst reforming feeds.

Both catalytic and thermal cracked naphthas can be processed for desulfurization and stability and engine-cleanliness improvements. Catalytic naphthas are substantially improved, with little or no loss in leaded octane, while some thermal naphthas may even show an increase in leaded octane.

Solvent naphthas from sulfur crudes can be Hydrofined to meet severe odor and corrosion specifications. Only mild conditions are required for the treatment of kerosine stocks to effect desulfurization and color and odor improvement. Hydrofining of tractor fuel reduces sulfur and provides stability control, with some reduction in clear octane.

Middle distillates . . . Virgin middle distillate can be Hydrofined for diesel-fuel production at a great reduction in sulfur and an upgrading on diesel index, color, and carbon residue. Although moderate severity is required, the yield remains at 100 per cent and long operating periods are possible without catalyst regeneration. In addition, cracked gas oils may be upgraded from fuel oil to diesel oil by this process.

For heating-oil production, both straightrun and cracked gas oils show improvement in stability and carbon-residue blending characteristics with mild Hydrofining. Heavy gas oils, both virgin and cracked, can be Hydrofined under moderately severe conditions to make higher-quality catalytic cracking feeds. As a result of the desulfurization, such feeds show a 4 to 5 per cent higher gasoline yield on catalytic cracking. The gasoline has a much lower sulfur content, a slightly higher octane rating, and better stability. More severe conditions are required for Hydrofining of coker gas oils, but the desulfurized middle distillate product is suitable for blending to heating oil.

Lube oils . . . Hydrofining can be substituted for acid treating of second-line lubricating oils from naphthenic stocks to give improvement in color, neutralization number, Conradson carbon, and sulfur content. Moreover, the catalytic process gives a 100 per cent yield at conditions of intermediate severity. Hydrofining can also be used in place of clay finishing of premium-extracted motor oils, giving equivalent improvement,

as shown in engine-performance tests. Hydrofining is also being employed commercially to upgrade petroleum waxes.

A variety of catalysts are available for the Hydrofining process. Cobalt and molybdenum oxides on alumina are used for some purposes, while other metal oxides have proved superior for other operations. Regeneration is possible if necessary, and catalyst life ranges from 6 to 12 months.

The process has been proved successful in seven commercial units with a total capacity of over 55,000 bbl. per day, covering a wide variety of operations. The Hydrofining process was developed by Esso Research & Engineering Co., licensors.

References

"Hydrofining's Use in Product Improvement," by A. C. Patterson and M. C. K. Jones, The Oil and Gas Journal, October 18, 1954, p. 92.

"Hydrofining Improves Low-Cost Lube Quality," by Dr. W. A. Jones, The Oil and Gas Journal, November 1, 1954, p. 81.

"Hydrofining of Middle Distillates," by Robert C. Morebeck, The Oil and Gas Journal, January 3, 1955, p. 94.

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HYDROFINING DIESEL FUELS

	West Texas (308°-641° F.)			Elk Basin (478°-634° F.)		83% Virgin Arabian 17% Cat. stock (495°-682° F.)	
	Feed	Products		Feed	Product	Feed	Product
Sulfur	0.92	0.15	0.50	1.3	0.25	1.6	0.35
Copper number	92	<1	<1	34	<1		<1
Gravity, A.P.I.	37.9	38.4	38.4	31.4	33.5	30	32
Aniline point	143	150	145	154	154	151	154
Diesel index	54	58	56	48	52	45	50
Cetane number	...	53-55	53-55	46	46	51	52
Bromine	...	...	...	...	...	10	1
Color, TR	17	17	18	14	22		
Carbon residue, 10 per cent	0.03	...	0.04	0.02	0.02	0.06	0.02

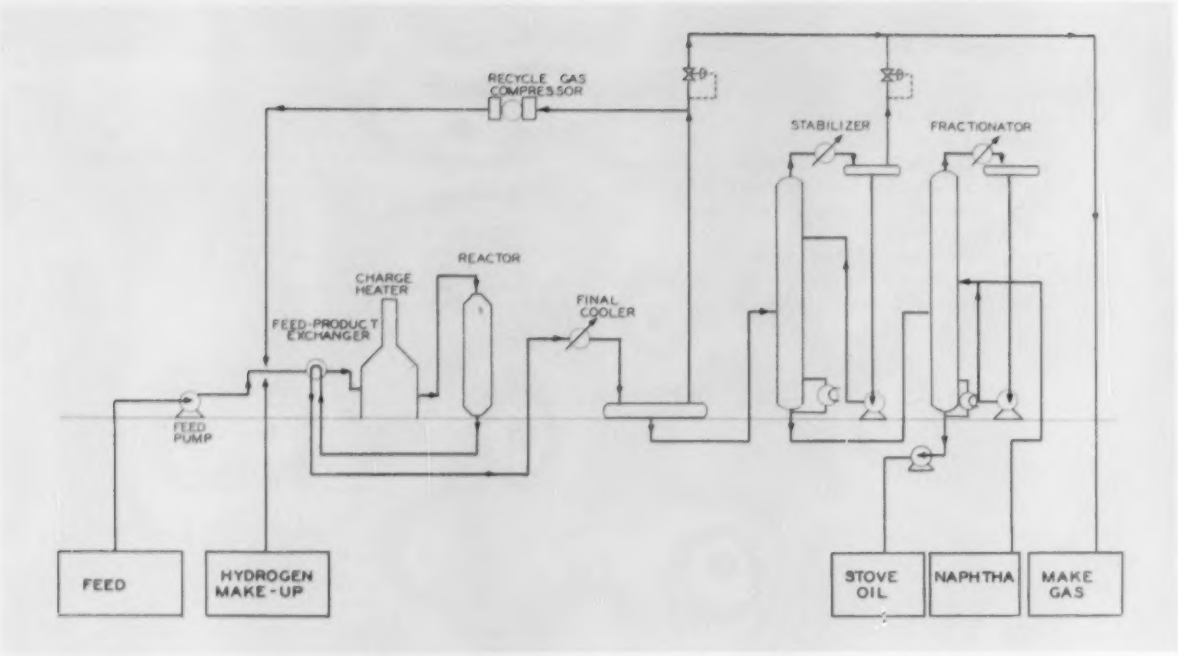
HYDROFINING VS. ACID TREATING OF CRACKED NAPHTHAS

	Heavy cat. naphtha 250°-442° F. e.p.			Heavy thermal naphtha 300°-450° F. e.p.		
	Feed	Hydrofining	Acid* treating	Feed	Hydrofining	Acid* treating
Sulfur, weight per cent	0.24	0.07	0.21	0.28	0.12	0.17
Bromine number	23	17	19	34	24	31
General motor gum†	3	0.5/2.4	3	12	0.5/1.0	2
A.S.T.M. breakdown, min.	465	1,440+	790	70	1,440	250
FL-2 rating, per cent of reference‡	96	77	66	107	56	50
C.F.R.R. octane:						
Clear	92.5	90.5	91.5	59.5	52.5	59.5
+ 2.0 ml. TEL	96.0	95.5	95.0	70.0	69.0	70.0
Yield, volume per cent	...	100	§98	...	100	§97

*Four pounds per barrel of 76 per cent acid. †Inhibited with 2 lb. per 5,000 gal. of phenylene-diamine type inhibitor. ‡Current commercial gasolines show an FL-2 rating of 70 per cent of reference fuel. §After rerunning.

EFFECT OF HYDROFINING ON LABORATORY QUALITY MOTOR OILS FROM LEDUC CRUDE

	10 grade		30 grade		60 grade	
	Charge	Product	Charge	Product	Charge	Product
Viscosity S.s.U. at 100° F.	165	157	607	575	1,708	1,603
Viscosity index	85	91	87	90	90	91
Sulfur, per cent	0.19	0.05	0.19	0.03	0.20	0.06
Color, Robinson	11	21	7	17	1	10
S.E. number	64	36	260	20	1,200	150
Conradson carbon	0.03	<0.01	0.04	0.01	0.27	0.14
Sligh oxidation, 24-hr. sludge, mg./10 g.	46	<1.0	21	<1.0	2	1



Unifining

UNIFINING is a versatile means of removing sulfur, nitrogen, oxygen, and metal contaminants from petroleum distillates. In addition, an improvement in the characteristics of these stocks is realized.

The process may be applied to fractions of wide boiling ranges, from gasolines to heavy vacuum distillations, either straightrun or cracked, of high-sulfur content or low. The objectives of Unifining include:

1. Improvement in odor and color stability.
2. Pretreatment of catalytic reformer charge stocks.
3. Reduction in sulfur and nitrogen compounds.
4. Improvement in burning properties, cetane number, and susceptibility to catalytic cracking.

Description . . . The accompanying diagram shows an equipment arrangement for the simultaneous preparation of catalytic reformer feed and high-grade stove oil by the processing of coker distillates. The feed is combined with hydrogen recycle gas, preheated by heat exchange with reactor products, and heated to the required reactor inlet temperatures. On passing through the reactor, the desired catalytic reactions are accomplished and depending on the specific application, these may occur in either vapor phase or mixed-phase conditions. The reactor products, after heat exchange, are cooled and flow to a high-pressure separator. The hydrogen-rich gas is recycled back to the reactor. Any excess over process requirements is vented to fuel. The high-pressure separator liquid flows to a stabilizer for removal of dissolved light gases and is shown in this figure as a conventional refluxed stabilizer. In other specific applications this stabilizer may be replaced by a stripper, rectified absorber, or other comparable equipment. The stabilized product is then ready for fractionation as indicated in this flow diagram, or may be utilized directly.

This is but one example of Unifining application. Since the Unifining process has application to such a broad range of charging stocks and is operated to obtain many different end results, it is impossible to give a completely typical flow description.

Products and yields . . . Typical results are indicated below when Unifining a mixture of high-sulfur heavy naphthas and when Unifining a diesel oil.

	Calif. mixed thermal and str. heavy naphtha		Wyoming diesel oil	
	Charge	Product	Charge	Product
Gravity, °A.P.I.	46.1	51.1	31.3	34.8
A.S.T.M. dist., °F.:				
Initial	221	196	452	260
10 per cent	257	249	523	492
50 per cent	313	310	560	547
90 per cent	390	385	603	596
Max.	440	446	640	644
Sulfur, wt. per cent	1.9	0.008	2.1	0.14
Bromine No.	20	<1	...	...
Nitrogen, p.p.m.	130	10	...	...
Cetane No.	...	...	46	52
Liquid yield, Vol. per cent charge	...	101	...	100

"The products from Unifining are often better in marketability than those made by acid and caustic treating."

Results of two other applications of the Unifining process are given below. Liquid yields are generally very high, with liquid recoveries above 100 per cent of charge frequently experienced. Operating severity can be readily controlled to give the desired degree of desulfurization of olefin saturation by suitable choice of process conditions.

	S.r. naphtha and coker dist.		Wyoming light cycle oil	
Charging stock—	Feed	Prod.	Feed	Prod.
°A.P.I.	50.3	50.9	19.3	26.3
A.S.T.M. dist., °F.:				
I.b.p.	254	254	430	395
10 per cent	280	279	458	420
50 per cent	322	327	483	462
90 per cent	406	414	515	508
End point	456	472	554	580
Total sulfur, wt. per cent	0.11	0.001	2.54	0.06
Mercaptan sulfur, wt. per cent	0.02	Nil		Dr. neg.
Basic nitrogen, p.p.m.	25.9	<1	48	7
Total nitrogen, p.p.m.	43.1	<1		
Bromine number	12.9	0.4	21.8	2.7
Arsenic, lb. per bbl.	27	<1		
Cetane number				
H_2 content, wt. per cent			9.86	11.25
Liquid yield, vol. per cent of charge		100.0		100.8

Results from Unifining heavier stocks are as follows:

UNIFINING HEAVY DISTILLATES

	Santa Maria coker distillate		Heavy vacuum gas oil	
	Charge	Unifined product	Charge	Unifined product
Gravity, °A.P.I.	26.9	39.0	23.6	27.2
A.S.T.M. distillation, °F.:				
I.b.p.	210	170	576	440
10 per cent	318	285	674	600
50 per cent	569	467	793	760
90 per cent	870	722	879	870
95 per cent	901	759		
Maximum			*902	*894
Sulfur, wt. per cent	3.9	0.05	1.94	0.39
Bromine No.		0.5		
Nitrogen, wt. per cent	0.24	0.05		
Liquid yield, vol. per cent		102		100.4
Chemical hydrogen consumption, cu. ft. per bbl.		800		170

*97 per cent over.

UNIFINING CRACKED MIDDLE DISTILLATES

	Visbreaker distillate		Catalytically cracked cycle oil	
	Charge	Product	Charge	Product
Gravity, °A.P.I.	37.3	39.2	26.0	30.0
Distillation, °F.:				
I.b.p.	365	350	451	301
10 per cent	411	404	483	442
50 per cent	450	446	531	518
90 per cent	510	507	587	588
End point	563	567	618	624
Sulfur, wt. per cent	0.45	0.02	1.15	0.18
Bromine No.	45	3.0	19	8
Aromatics + olefins, per cent	58.9	29.1	50.4	48.9
Yield, vol. per cent		101.3		101.3
Color, A.S.T.M. Union:				
Initially	5	Lt. 1	1	1
After 6 months	5	1	4½	3
Chemical hydrogen consumption, cu. ft. per bbl.		330		190

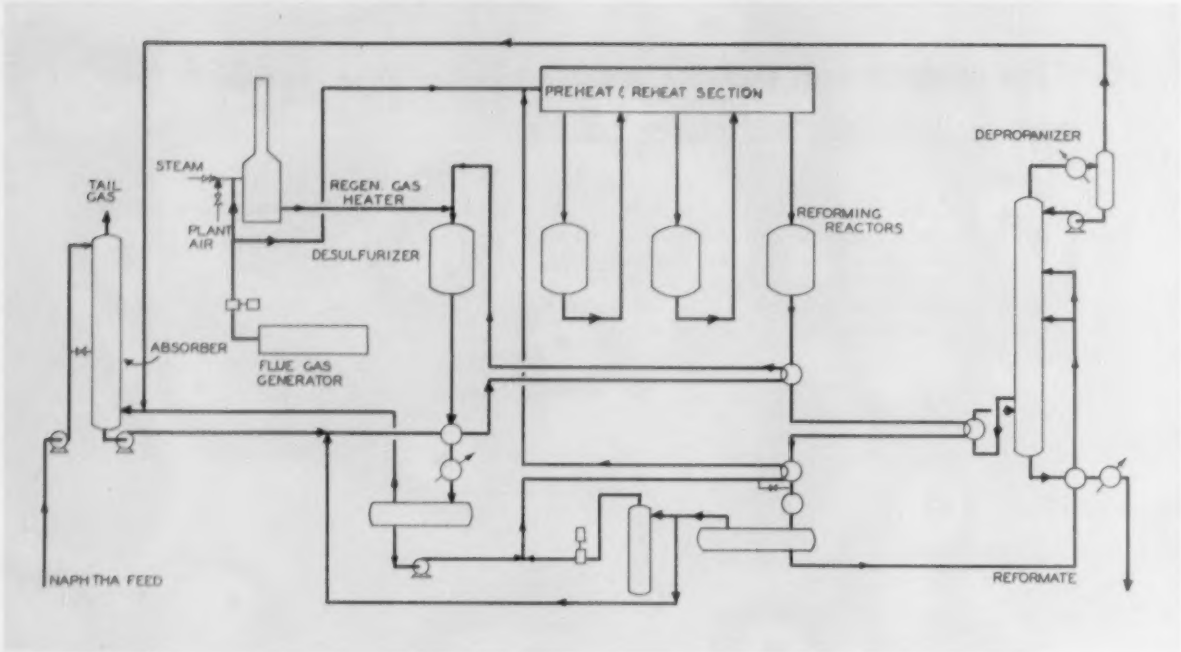
The reactions occurring in Unifining consume hydrogen which must be supplied from an outside source. Most commonly, this is byproduct hydrogen from catalytic reforming but may be supplied by other gases of relatively high hydrogen content. Frequently, there is significant additional recovery of C_4 and C_5 when excess reformer gas is supplied to the Unifining unit.

Commercial installations . . . The first commercial installation was made in 1953. At the present time nearly 30 units are in the process of design and construction. (A license to use the Unifining process may be procured through either the commercial development division of Union Oil Co. of California or Universal Oil Products Co.)

Units are in operation feeding straightrun gasolines, thermally cracked and coker naphthas straightrun kerosines, and thermally cracked gas oils. Additional units under construction or in final design will extend the range of charge stocks to include diesel oils, catalytic naphthas and cycle stocks, aromatic distillates, and vacuum gas oils.

Unifining has found broad application in the pretreatment of both straightrun and cracked naphthas in order to convert them into ideal charge stock for reforming. Another important application is to improve color and color stability of distillates. The degree of improvement is such that even catalytically cracked cycle stocks of the correct boiling range can be upgraded to a No. 1 fuel component. Kerosine and solvent fractions are definitely improved in odor by Unifining.

The products from Unifining are often better in marketability than those made by acid and caustic treating. Quality products are obtained without the losses and the nuisances involved in disposal of wastes from conventional treating.



Catalytic Reforming and Feed Desulfurization

THE modern concept of catalytic reforming calls for the integration of catalytic desulfurization of feed stocks. This combination process, designed and licensed by M. W. Kellogg Co., utilizes a platinum catalyst developed by Sinclair Research Laboratories and Baker & Co. Byproduct hydrogen from the reforming reactions is combined catalytically with sulfur compounds in the naphtha feed, to produce hydrogen sulfide which is removed from the system with tail gas.

This combination process permits an unusually high yield-octane relationship at low utility consumption.

Operation . . . Fresh naphtha feed is first charged to an absorber which also serves as a stripper, removing any dissolved oxygen and water from the incoming charge. This absorber takes overhead gas streams from the desulfurizer separator drum and the depropanizer, to assure maximum recovery of butane and heavier hydrocarbons.

Hydrogen-rich gas from the reformer is mixed with the stripped naphtha and the combined streams are heated by exchange with desulfurizer and reformer effluents. This preheat brings the charge stock to the required level for selective catalytic hydrogenation of sulfur compounds in the desulfurizer reactor.

Desulfurized reformer feed is combined with recycle hydrogen and charged to the preheat coil of the preheat and reheat unit. The stream then passes through the three reforming reactors in series, with intermediate reheating to correct the temperature drop brought about by the endothermic reforming reactions.

Effluent from the third reactor passes to the high-pressure separator where a H_2S-free, hydrogen-rich gas is disengaged for recycling to the desulfurizer and reformer reactors. The liquid reformate is charged to the depropanizer column and withdrawn as finished product.

Catalysts in both the desulfurizer and reformer reactors can be regenerated in place. This is accomplished in blocked operation at atmospheric pressure.

Results . . . This combination unit will upgrade a 38.4 octane, paraffinic, Mid-Continent naphtha to a reformate testing 90 research octane clear, and over 98 octane with 3 cc. of TEL. The yield under these conditions is better than 89 per cent. Sulfur in the feed is converted to H_2S by catalytic hydrogenation. Hydrogen sulfide is removed from the system ahead of reforming. The yield and product inspection data shown here are typical for commercial operation charging a Mid-Continent naphtha.

Feed:	
Barrels per stream day	3,092
Gravity, °A.P.I.	53.6
I.b.p., °F.	244
E.p., °F.	394-402
Sulfur, weight per cent	0.032
C.F.R.-R clear	38.4
Product:	
Reformate:	Stab.
Gravity, °A.P.I.	48.5
I.b.p., °F.	101
E.p., °F.	413
Sulfur, weight per cent	0.0016
C.F.R.-R clear	90.1
Yields:	
Butanes, volume per cent	5.9
Hydrogen, s.c.f./bbl.	900
Stabilized reformate, volume per cent	89.1

WHAT'S AHEAD FOR CATALYSIS?

Here's how a group of representative researchers view the future of catalysis. They venture some predictions on how catalytic processes will aid in the development of future refining techniques.

Needed: Pilot Method That Gives Realistic Commercial Results

A. H. Boultbee
Manager, Manufacturing Research Department, Shell Oil Co., New York.

THE use of catalysts in the petroleum industry is as old as the industry. In many sulfuric acid treating processes, one of the functions of the acid is catalytic. In clay treating adsorption may be the chief physical effect, but the catalytic activity of the clay is a contributing factor.

However, the catalytic era in the industry really began in the 1930's with the application of solid catalysts to vapor-phase reactions, e.g., polymerization, hydroforming, and catalytic cracking. The trend to technological development during the war years enlarged the use of catalysts so that now in a modern refinery approximately one-half the barrel of crude oil is converted in catalytic reactions.

Present processes . . . Of the current commercial processes, two general types predominate—catalytic cracking of heavy distillates and catalytic reforming of naphthas. In considering the future it is well to assess the past, and these two processes serve as good examples.

The original commercial catalytic cracking process used natural clay as a catalyst. Under the stimulus of the impending world war, there was great activity in catalytic cracking technology. One of the results was a synthetic silica alumina catalyst. Since that time, this catalyst has been improved, notably by being made available as a microspheroid, and also more recently as the new so-called "high alumina" form.

The success of the synthetic silica alumina catalyst may be gaged by the fact that it constitutes over 80 per cent of all the cracking catalysts used. However, the knowledge now available on the mechanism of catalytic cracking and on the basic understanding of this type of catalyst will surely lead to other improvements.

One of the barriers to such improvements is the difficulty of assessing the commercial performance of a new catalyst, except by full-scale commercial trials. These are expensive, involve big financial risk, and pose problems of supplies of experimental catalysts for such tests.

This problem exists some in the development of new catalysts for other processes, but it is accentuated with catalytic cracking. Here small-scale equipment is inadequate to reproduce the fluid dynamic and thermal conditions prevailing in commercial catalytic cracking units. For this reason, perhaps the prime need for pushing further improvements in catalytic cracking is a technique to permit confident scaling up of the performance of experimental catalysts.

Turning now to catalytic reforming, another lesson can be learned. Platinum catalysts have long been known for a variety of reactions and their role in hydrocarbon conversions was well explored during the 1920's by Zelinsky. Commercially, platinum was used as a catalyst in the contact sulfuric acid process, but because of its cost and susceptibility to poisons successful research was begun which resulted in its replacement by vanadium catalysts. The thought that platinum was too expensive for use as a catalyst in oil processes hindered its development.

Look at Product Credits First

It is to the credit of Haensel and U.O.P. that they overcame this obstacle and developed the first successful commercial process wherein platinum was used in hydrocarbon conversions. The lesson to be learned is that, in considering new catalytic processes, one's approach should be first to look at the product credits that can be gained without being inhibited by the apparent cost of the catalyst.

If the product credits are sufficient, there is a good chance that further development work can reduce the catalyst cost to a level where commercial exploitation is warranted.

The process of hydrodesulfurization is in a different category. Some plants are in operation, others are building, and there is much development activity. There are fully developed processes using a variety of catalysts, most being derived from the cobalt molybdenum type. The problem here is not so much technical as economic. Certainly this will be resolved as the industry continues its historic trend by delivering higher and higher quality products to its customers.

Next: Improvement of Heavy Virgin And Cracked Distillates

T. H. Rogers
Director of Research, Standard Oil Co. (Indiana), Whiting, Ind.

USE of catalysts on a major scale in petroleum refining was rather slow to arrive. But once catalytic conversions were introduced, acceptance was swift. Within two decades, the petroleum industry largely replaced thermal cracking and reforming with catalytic equivalents. Catalytic polymerization and alkylation are

widespread. In finishing the products of petroleum and in making chemicals from them, catalysts direct reactions of ever-greater variety.

Not that catalytic processing of petroleum is a fully developed art. More than minor improvements are still needed. Too many pounds of catalyst are used to process a barrel of feed. Reactions are seldom clean cut. Catalysts that are more active and more selective, once invented, will inevitably be developed to lower the costs of present operations. In recent years advanced analytical techniques have greatly aided research on catalysts, but the full benefits have yet to be reaped.

Product quality . . . In the near future, new catalytic processes for refining petroleum will emphasize product quality. Hydrogen now available from the reforming of naphthas has at last made practical the upgrading of heavier petroleum distillates by hydrogenation. Developments in metallurgy will eliminate the corrosion that has prevented isomerization of paraffins from adding higher octane numbers to gasoline.

Sooner or later, catalysts will supply new sources of hydrocarbons to help meet the fantastic demand for liquid fuels. From distillates to residues to coals are but successive, if difficult, steps in development of catalytic hydrogenation. Shale oils will be refined by a series of catalytic processes. The chemicals produced from that operation will initially be an important source of revenue, similar to the current status of the hydrogen-carbon monoxide synthesis.

New discoveries . . . But these developments will be overshadowed by new discoveries. Homogeneous catalysts as well as heterogeneous will find application. Base and free-radical catalysts will be exploited as acid ones have been. The empirical search for new catalysts will continue, but fundamental approaches will be more fruitful. New concepts will organize our knowledge of catalysis; perhaps the key will come to a chemist dozing in a passenger plane over the Rockies, as the concept of the benzene ring came to Kekule in a London hansom cab.

Future catalyst developments, like past ones, will require coordinated teamwork. The catalyst team must keep in touch with other research teams: the economics team, to guard against unprofitable processes; the engineering team, to improve the techniques of catalyst application; and the evaluation team, to fit products to tomorrow's engines and turbines. The members of the catalyst team will be key men in a busy field.

Search for the Ideal Catalyst Will Continue to Be Pushed

Frederic H. Holmes
Vice President, Research and Technical Department,
The Texas Co.

THE petroleum industry has continually attempted to improve its processes and products for the benefit of the consuming public. This has meant that, at first rather gradually and then at an accelerated rate, the naturally occurring components in crude oil have of necessity been modified by various processing techniques.

Initially the use of selected pressure-temperature-time conditions satisfactorily produced the desired changes in structure and distribution of petroleum hydrocarbons. However, as the demand for higher-quality products has increased it has been necessary to develop and put into operation processes which depend upon the presence of a catalyst to obtain the required result.

It certainly appears that this trend will continue to increase with the result that catalytic processes will play an even more important role in future refinery operations.

Cat reforming . . . The past 2 years, for example, have witnessed major expansion in the catalytic reforming of gasoline fractions to improve their octane characteristics. It appears probable that this trend will continue as long as suitable feed stocks are available. Further, with demand continuing for the production of better motor gasolines, supplementary or complementary processes will probably be developed.

The above example should not be taken to mean that further progress in the application of catalysts will be confined to motor fuel production. The industry is continually studying methods for improving its many products and increasing the yield of those most in demand. All indications are that major changes along these lines in the future will necessitate increased study and application of catalytic processing.

Catalysts . . . In addition to work leading to the development of catalysts for new processes, it seems evident that further improvements will be forthcoming in the catalysts for processes now in operation. Whether ideal catalysts, that is materials which can be used for an indefinite period without loss in the activity or selectivity, will ever be forthcoming is open to question but it is reasonable to assume that this will be a much sought-after goal.

Look for Catalytic Cracking of Crude Residua and Shale Oil

J. C. Dart
Manager, Research and Development Division,
Houdry Process Corp.

THE petroleum industry's growth during the past 25 years has resulted largely from work in research and engineering, particularly in catalytic cracking and catalytic reforming. This has led to new products and marked improvement in yield and quality of liquid fuels. Material increases in basic product costs have not resulted, despite general price rises and dollar evaluation.

Since these catalytic processes have exhibited such wide acceptance, one can logically ask what may we now foresee in the next few years. **Broadly speaking,** the order of the day will be continued upgrading for all the major products from crude oil.

Petrochemicals . . . A larger portion of refined products will be utilized as building blocks for the expanding chemical industry. This will include light olefins and diolefins and low-boiling aromatics. Catalytic processes now in use will be expanded to meet these re-

quirements. Improved catalysts to allow greater flexibility in processing can be expected. They will be more rugged and will maintain their catalytic properties for long periods of time.

Catalytic reforming will become the major process to meet the high-octane demands for motor fuels. Look for 100 clear octane catalytic reforming to be standard operation. This will be achieved by more selective catalytic processing. Current basic types of reforming catalysts will require only slight modifications to meet these needs. Expect no large-scale reforming of catalytic gasoline.

Residuum and shale . . . Look for the solution to be effected, with commercial acceptance, in catalytic processing of crude residua and shale oil. This will outmode thermal and coking processes, as now practiced. Ultimate elimination from the refinery of excess heavy fuel can be brought about. Expect no large-scale hydrocracking to upgrade low-quality residua. However, hydrogenation and desulfurization will be practiced on an ever-expanding scale to improve low-quality gas oils for catalytic cracking, jet fuel, diesel, and domestic burning oil.

Catalytic cracking will continue to expand to provide a greater production of high-quality gasoline. The trend in cracking catalysts will be to modify the catalysts to obtain improved catalyst stability and maximize gasoline octane number.

Research and engineering will continue to pace the industry. Their results will confirm the belief that it is not impossible to invent new processes. The real difficulty arises in making them econo.nically acceptable.

Catalysis May Help Solve Two Formidable Industry Problems

. . . Say Socony-Vacuum Laboratories researchers

THE vital role now played by catalytic processes in petroleum refining is keyed to ever-increasing demands on the performance of motor gasoline and distillate fuel oils. In particular, the automotive industry's program to provide the public with cars having both high power and efficiency has presented the petroleum industry with a challenge to produce gasolines of higher octane number and to face the problem of combustion-chamber deposit and autoignition. This trend shows no sign of slackening and is expected to continue at an accelerated pace.

Present processes . . . Resort to catalysis to solve these problems, as typified by the rapid growth of catalytic reforming, has a fundamental basis. No other technological tool now known offers the power and versatility of catalytic processes. The profound effects of catalysts upon chemical reactions provide innumerable variations for process development, in which catalyst composition as well as process conditions may be changed over a wide range.

As product requirements grow more stringent, it may be expected that catalysis will be called upon more and more to meet them. Examples of processes currently growing in importance are catalytic reforming and catalytic desulfurization. Improvements and modifications in both these fields are continually being sought. At the same time other fields, such as catalytic cracking, are by no means closed books.

In the future . . . Turning to applications which are less firmly established, two major ones are the utilization of light hydrocarbons and the upgrading of heavy stocks and residua. Both are notoriously formidable problems. Known processes for converting light hydrocarbons to liquid fuels or to chemicals are of limited scope and are economically attractive only within limited fields. Catalysis may yet prove to offer a fruitful attack on this problem.

The upgrading of heavy stocks and residua has been the subject of extensive catalytic research, particularly in Germany, by the route of hydrogenolysis cracking. The economics of the processes developed are very questionable in today's petroleum technology. However, the need, both from the standpoint of meeting competitive pressures and of conserving supplies of petroleum, is constantly increasing. Here again is a field in which the versatility of catalysis makes it a natural method of attack.

Summing up, catalysis is fundamentally a very powerful technological tool, possessing unique features for processes involving chemical reactions. It will continue to be applied and extended in the fields where it presently dominates and offers promise for the future in many others.

Look for Higher Octanes From Paraffinic Naphthas

. . . Say Phillips Petroleum Co. scientists

WIDESPREAD use of catalysts in petroleum refining is relatively new. In the late thirties polymerization of light olefins to produce liquid products and catalytic desulfurization of naphtha marked the first major steps in the displacement of thermal and chemical treatment by catalytic treating processes. By the start of World War II catalytic reforming of naphthas and catalytic cracking of distillates had gained a foothold in the refining of petroleum.

Under the urgency of the mobilization program, catalytic cracking grew rapidly and new alkylation processes for converting light hydrocarbons into super aviation fuels were moved from the laboratories to the refineries. Postwar modifications of catalytic reforming have led to wide use of more efficient platinum-type catalysts.

Hydrogenation . . . As a result of the greater use of catalytic reforming and the hydrogen produced as a byproduct, the petroleum industry is now entering an era of hydrorefining of crude oil. Processes employing catalytic hydrogenation to desulfurize, increase stability, and otherwise improve the processability and utility of naphthas, burning oils, and other distillate products are going rapidly into commercial operation.

The next area of commercial interest is improvement of heavy virgin and cracked distillates. Treatment with hydrogen will remove sulfur from catalytic cracking feed stocks and reduce carbon deposition in the

cracking step. Still further in the future is the hydrocracking of heavy distillates and nonvaporizable residuums into lighter distillates and naphtha of low sulfur content.

Increased yields . . . Modifications of present catalytic processes to improve product yield or qualities can be expected. Thus, cracking catalysts which produce less coke or effect deeper conversions per pass could improve the economics of catalytic cracking. Present catalytic reforming processes perform to best advantage on naphthenic stocks or low-boiling paraffins. Changes in catalyst and operating conditions to achieve maximum octane number improvement from the paraffinic naphthas can be expected in the future.

New catalysts . . . New catalyst raw materials are being investigated as the possible basis for future processes. Rare earth metal oxides, for example, are becoming available as a byproduct of atomic-energy activities. Improved beneficiation processes for low-grade ores, and more efficient extraction processes are now being developed for metals such as titanium and zirconium. Some of these increasingly available materials will undoubtedly prove to have desirable catalytic properties in petroleum-refinery operations.

The newer catalytic processes will continue to show the practicality of using several simultaneous chemical reactions which can be accented separately at will by changing operating conditions and modifying the catalyst. The fundamental knowledge of hydrocarbon chemistory built up in the last few years makes this possible. A trend in this direction in catalytic processes for refining is likely to be general, and important for fitting petroleum products to more and more discriminating standards of end use.

Operations Will Be Controlled to Increase Yields of Middle Distillates

W. M. Flowers
Sinclair Research Laboratories, Inc.

POLYMERIZATION of propylene and butylenes by phosphoric and sulfuric acid catalysts was the first significant catalytic process. Refiners will continue the application of these processes as determined by the economics of competitive demands for the olefins in each refinery. Petrochemical uses in general are more profitable.

Alkylation with sulfuric and hydrofluoric acid catalysts becomes more attractive as the octanes of motor gasolines are forced upward. The trend of increasing the distillate fuel to gasoline ratio in some cases will limit the supply of isobutane from catalytic cracking, even though synthetic cracking catalysts will be employed more extensively. This may require additional catalytic **isomerization** capacity in certain locations to provide isobutane.

Catalytic cracking will continue to expand in this country, although the higher ratio of distillate fuel demand may favor catalytic reforming in some European refineries. The use of improved synthetic fluid cracking catalysts will be emphasized in order to achieve better control of product distribution, increase the capacity of existing units, and improve the resistance of catalysts to metals, sulfur, and nitrogen poisons. Cracking operations will be controlled to increase the yields of middle distillates.

Catalytic reforming must be expanded rapidly to enable the refiner to produce the premium gasolines which are moving to 100 octane. Reforming severity will increase to produce 95 and higher clear octane component. This requires better platinum-type catalysts. Regenerative platinum catalysts will be emphasized in order to obtain economic productivity of barrels of reformate per pound of catalyst.

Improvements are expected in fluidized reforming. Reformer feed stocks will include more cracked naphthas and some will require hydrodesulfurization pretreating. Production of pure aromatic hydrocarbons will expand rapidly by platinum catalyst reforming to meet present and future petrochemical demands. Although aromatic and other petrochemical production will be an important dollar volume the major reforming capacity for motor gasolines will rapidly reach over 600,000 bbl. per day.

Hydrodesulfurization of reformer feed stocks will expand as required by higher sulfur crudes and increased ratios of cracked naphthas for individual refinery applications. The cobalt-molybdenum type of catalyst will be employed. Cycle stocks for distillate fuels will be desulfurized and stabilized by hydrogenation in addition to some high-sulfur virgin distillates in order to improve the competitive quality of heating and diesel oils. This major application will expand rapidly parallel with the hydrogen supply from the reformers.

Lube hydrorefining with sulfur resistant catalysts is attractive in certain applications and will be expanded by utilizing hydrogen from reformers. Improvements in color, oxidation stability, and added compatibility will be exploited first. However, more complete hydrogenation for additional quality including higher viscosity index will be developed especially with the future improvements in catalysts.

Hydrocracking may become the most important future catalytic development due to the advantages it will provide for the control of heavy-fuels production. Hydrocrudes from residual oils will be produced with better refining characteristics than the original crudes but the ultimate application of this type of process will require additional inexpensive hydrogen. Also sulfur-resistant catalysts will be improved in order to permit processing at lower pressures with better selectivities and economic catalyst life.

"Greatest Development in Field of Petroleum Since Drake's Discovery"

M. D. Gilchrist
Vice president, Universal Oil Products Co.

IN attempting to look forward to the future of catalysis in the field of petroleum refining one must briefly review its history. Prior to the thirties catalysis was primarily of interest to scientists in research laboratories and very few of the catalytic reactions discovered found practical use. However, this work has

served as a background for our present progress in catalysis.

At the outbreak of World War II catalysis in the field of petroleum refining was in its infancy. Phosphoric acid polymerization was the most widely used catalytic process at that time with processes such as isoparaffin-olefin alkylation and catalytic cracking beginning to find a place. With war and the tremendous demand for munitions, aviation and motor gasolines, synthetic rubber, plastics, and other products of a similar nature, it became necessary to change ideas relative to the production of these materials.

Up to this time the refining industry had depended primarily on distillation and cracking employing temperature and pressure to make the desired products. However, it was obvious that the quality and quantity could not be reached by these conventional methods and catalysis was drafted to aid in this terrific undertaking. It can be said that it did a man-size job in helping to bring that great war to a successful conclusion.

Wartime operations . . . Due to the lack of petroleum in certain countries, such as Germany, Italy, Great Britain, and Japan catalytic processes had been employed in the processing of coal and byproducts from coal for the production of synthetic products. But with our vast natural petroleum resources this was uneconomical and while certain experimental catalytic processes, such as were used abroad, had been installed and operated in this country, they were considered impractical.

Some of the catalytic processes which were used to produce materials for war were catalytic cracking, alkylation, isomerization, dehydrogenation, aromatization, polymerization, and hydrogenation. Several of these processes were taken directly from the laboratory and designed into processes for commercial use without the usual pilot-plant development.

Catalytic reforming . . . The success of catalysis was such that it readily found a place in our postwar economy and has been used extensively over the past years and many new catalytic processes have been developed and are now in use. One of the most prominent of these from the refiner's viewpoint is U.O.P. Platforming. This is a process developed primarily for the upgrading of low-quality straightrun gasolines and for production of aromatics such as benzene, toluene, and xylenes. The catalyst for this process contains the noble metal platinum. Platinum until a few years ago was primarily used for jewelry; however, today the refining industry is one of its largest consumers.

If one will think back some 10 years he will recall the extreme shortage of aromatics, especially benzene. This shortage has now been overcome and these products are again available in quantities so that all demands can be readily fulfilled. This is an example of how catalysis has proved that catalytic processes for the refining industry are here to stay; in fact benzene produced catalytically from petroleum is superior to coal-tar benzene and for most chemical needs is preferred.

Hydrogenation . . . Catalytic reforming has not only given to the refining industry a means of upgrading low-quality gasolines and a means of economically producing aromatics, but in addition has given the industry a source of cheap hydrogen. This cheap hydrogen has made possible catalytic hydrodesulfurization of petroleum, catalytic hydrogenation of unsaturated hydrocarbons, and removal of various contaminants such as arsenic, sulfur, and nitrogen which adversely affect platinum catalysts.

So much for the brief history of catalysis in the refining industry. Now if one feels so ambitious as to gaze into the future he will find the horizon veiled in many new catalytic reactions producing more and better petroleum products and petrochemicals.

Catalytic Age

The refining industry has entered into a new era which one might call the "Catalytic Age." The 1955 automobile engine, which demands higher quality gasolines, is indicative of what the future will require of the refining industry. One-hundred-octane motor gasoline is something we can predict in the next few years and it is possible that this gasoline will carry a chemical composition as well as physical specifications such as octane number, volatility, etc.

To produce this gasoline it will have to be tailor-made. For example, it will consist of components such as aromatics, alkylate, and isopentane and they will, to a large part, be produced by catalytic reactions. Fuel oils will be products which are catalytically hydrofined in which deleterious impurities will be removed and undesirable components converted into high value fractions giving a fuel oil of high burning quality without the difficulty of burner deposits, undesirable odors, and maintenance problems which would result from using the fuel without hydrofining.

Catalysis will also make it possible to economically process the numerous low-gravity high-sulfur crude oils thereby adding to our store of natural resources. These crudes will be broken up into fractions, catalytically desulfurized, and further catalytically processed to produce high-quality products.

Natural gas . . . Another field in which one can look for outstanding catalytic developments is natural gas. Some progress has been made in this direction; however, the surface has only been scratched and it is reasonable to predict that we will soon see remarkable progress in the utilization of motor fuels, petrochemicals, and other valuable materials such as plastics, resins, etc., using natural gas as the raw material.

As regards the role of catalysis in the future, one must consider not only the catalytic reactions but also the type of catalyst. In most of the catalytic processes used in the refining industry, a very important factor is the carbon-forming tendency of the catalyst. Every scientist engaged in the development of catalysts is trying to produce a catalyst which will give the desired reactions with a minimum of carbon deposit.

This is exemplified by the platinum reforming catalyst, which is tailor made to produce the present high-octane-number products without the necessity of resorting to the expensive, complex, and troublesome operation of regeneration. Future increase in octane requirements can be met either by more severe processing conditions or by modifications in operating technique.

In the former method, presumably more carbon will be deposited and the catalyst will require regeneration. However, because regeneration is both costly

and troublesome, it definitely is preferred to use available modifications in operating technique to produce the higher octane numbers in continuous uninterrupted operations.

Catalytic cracking . . . In catalytic cracking this goal has not as yet been reached and it is necessary to use difficult and expensive regeneration. This can only be considered as a remedy and not as a cure. With the present knowledge of catalytic reactions, it is possible to direct the development of catalyst manufacture so as to produce a cracking catalyst which is designed to give the desired reactions with substantially no carbon formation. In this way, it also will be possible to produce other catalysts which will give specific reactions without undesirable side reactions and thus avoid the formation of products inferior to those desired.

So far we have dealt primarily with fuels for the internal-combustion engine and burning oils. However, with the advancement of jet engines and rockets we find a demand for a different type fuel. It is not too far fetched to predict that we may reach a point where gasolines such as we know today will be converted catalytically into jet fuels or broken down into lighter hydrocarbons and then recombined into chemicals suitable for rocket fuel.

Development of catalysts and catalytic processes will no doubt permit continued expansion in the field of petrochemicals. Pure hydrocarbons will be produced and these reacted to produce materials such as rubber, plastics, chemicals, cloth, paints, fertilizers, etc.

In this catalytic age it is impossible for one to foresee more than a few of the various possibilities that may result from catalytic treatment of petroleum; however, it is possible to say that catalysis is the greatest development in the field of petroleum refining since Drake discovered oil.

Increased Knowledge of Mechanism of Catalysis Will Speed New Processes

. . . Say Esso Research & Engineering researchers

CATALYTIC reactions play an important role in petroleum refining. Nevertheless, little is known about the basic nature of catalytic action and new catalysts are still developed principally by empirical procedures. It is reasonable to assume that an increased knowledge about the mechanism of catalytic action will facilitate the development of new catalysts and processes.

Accordingly, detailed studies are being made of the physical and chemical properties of catalysts. During the past two decades, many research tools were developed for studying catalysts. The more important of these are:

1. Adsorption studies
2. X-ray and electron diffraction
3. Electron microscope
4. Magnetic measurements
5. Electrical measurements
6. Isotope studies
7. Nuclear magnetic resonance.

New techniques . . . These techniques are being used at the Esso Laboratories in catalytic research. In alumina catalysts, for example, X-ray studies showed that the loss of activity due to overheating was the result of phase changes in the alumina. Moreover, the presence of other constituents affect the rate of phase change. Electron microscope pictures of used hydrocarbon synthesis catalysts showed for the first time the presence of a cuprene like material in the "coke" on the catalyst. This gave us an entirely new concept of a mechanism by which so-called "coke" is formed.

Again in hydrocarbon synthesis, a consideration of the crystal structure of catalytic materials permitted the prediction of catalyst behavior and led to new and better catalyst compositions. Adsorption studies giving pore size and surface area data have led to a number of interesting correlations between catalyst performance and these properties. Isotope exchange reactions added to our information about the alkylation reaction.

Problems . . . There are today a number of interesting problems facing the petroleum chemist. He knows, for example, that an oxide-type cracking catalyst also has polymerization, H_2 transfer, and isomerization activities. But he still has much to learn about the control of these activities. More work is needed to determine how the active components of a reforming catalyst are tied up with the support. In solving problems such as these, the above techniques will no doubt continue to be useful.

However, a point has been reached where emphasis in fundamental studies should perhaps be on the surface characteristics of the catalysts. It is necessary to know more about the structure of solid surfaces and about the bonding of the reactants to the surface, if a better understanding of catalysts and catalytic action is to be had.

When the Esso Research Co.'s radiation lab is completed this spring, among the things researchers will want to know is how gamma radiation will affect chemical reactions of interest to the petroleum industry —those reactions involved for example in the production of petrochemicals and those in a variety of refining processes. To get the answers they will build pilot plants small enough to fit in the shielded section of the laboratory. There, working with mechanical hands they will put the cobalt gamma ray source in the center of a pilot unit and methodically study its influence on the process.

Fuel Quality Will Keep Abreast Of Engine Designers' Requirements

H. W. Field
Vice president, Atlantic Refining Co.

THE horsepower race of our automobile industry together with the keen competition always present in the petroleum industry has been increasing the octane rating of the gasoline available to the public at a terrific pace. Catalytic cracking, alkylation, and now catalytic reforming have made available to the refiner, ways and means whereby he can stay in this race and operate for higher and higher antiknock levels.

However, even with these tools, all of us concerned with the longer-range future realize that certain

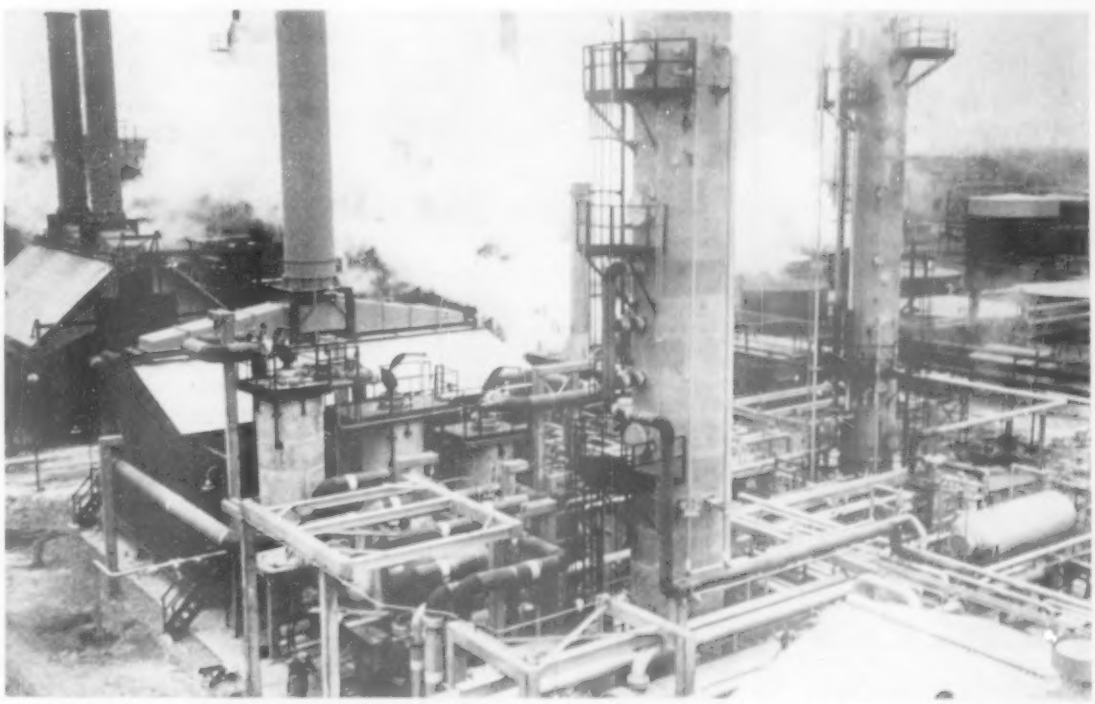
limitations are staring us in the face and some new approaches are required processwise to pierce the octane ceiling that we now see. It behooves us to take careful stock of where we now stand and plot some courses of action which might be taken.

Gasoline octanes . . . A critical look at what we are now accomplishing in the production of gasoline discloses two areas where none of the available processes does a particularly outstanding job in producing high-octane-gasoline components. Catalytic isomerization does a good job of handling pentane. Alkylation, catalytic cracking, and catalytic reforming do a very creditable job of handling the octanes and heavier. The rough spots are evident when we look carefully at what our available processes accomplish with respect to the hexanes and heptanes.

Straight-chain or mildly branched-chain hydrocarbons in this boiling range are not high-octane materials and unlike pentane, isomerization equilibria are not favorable to the production of high-octane components. Something more vigorous in the way of molecular rearrangement or possibly decomposition and reassembly of the molecule is a must, if these components in our motor gasoline are going to carry their full weight in producing high-quality products.

The crystal ball is hazy on just how these deficiencies can be overcome but as far as target objectives are concerned, the situation is reasonably well defined. I have no doubt that our research effort which for the petroleum industry as a whole is a mammoth operation, will come up with the answers before car octane requirements tend to outrun the quality of the available motor fuel.

NOT SPAGHETTI, but a material which some day may help produce oil products. Oil scientists at Esso Laboratories are studying its use as a catalyst. It was made in this shape by extrusion and will be broken up later into small particles for extensive experiments in pilot plants.



HOUDRIFORMER at Crown Central Petroleum Corp., Pasadena, Tex. It has a nominal capacity of 5,000 bbl. per stream day, and can be operated for high-octane motor fuel, aviation blending stocks, or aromatics. Houdriformer reactors are visible to left of tower in foreground, which conceals "guard case" reactor from view.

CATALYSIS-

All for Some . . . And Some for All

This comprehensive article by Dr. Oblad gives a clear, complete summary of the status and possible future of catalysis in the petroleum industry.

It will stand close scrutiny by the authorities in the field—*YET* there is something here for all our readers, technically trained or not. The more general points and conclusions are indicated by bold-face quotes, located at various points throughout the article.

Expert or novice, we believe you'll know more about catalytic processing of oil and gas after you have read this.

"Getting more valuable products out of every barrel of crude oil is the objective of the petroleum industry. Catalysts will play an increasingly important role in achieving this goal."

by Dr. Alex G. Oblad

IT has been pointed out to all of us that mankind faces possible extinction on this earth through the advent of the atom and hydrogen bombs. Through magazines, newspapers, radio, television or from the speakers' platforms this likely calamity is pounded into our ears ceaselessly.

Much less heralded is the story of another highly destructive device. This story has to do with the discovery of certain chemical compounds which have fantastically potent activity for destroying human and other forms of animal life. These substances are effective in the merest of traces. How can a substance be so effective in destroying life?

The answer lies in the subject I want to discuss in this article. We know that all life processes are carried on by substances known as enzymes. Enzymes are nature's agents for making ordinarily stubborn reactions occur at very moderate temperatures, pressures, and concentrations. Enzymes are biological catalysts. Prominent among the enzyme systems are those concerned with the passage of nerve impulses. Such enzymes form an infinitesimal part by weight of the total weight of any animal.

If it were possible to develop an antienzyme or catalyst poison for those particular kinds of enzymes associated with the nervous control of a vital functioning organ, then we would have at our disposal a most potent kind of biological warfare agent. Chemicals have been developed which specifically neutralize a particular vital enzyme. The neutralized enzyme cannot carry out its vital function, and, as a result, life quickly ends.

Let's get over to the consideration of more constructive aspects of the subject. I should like to review some of the landmarks in the history of catalysis, particularly that dealing with the scientific aspects of the subject. Also, I wish to discuss the current status of our thinking on the nature of catalysis and finally present some of the chemistry involved in the more important catalytic processes currently being used in the petroleum industry.

Let's Define Some Terms . . .

Energy and Equilibrium

To introduce the subject, it might be well to consider some of the definitions and important factors entering into catalytic reactions. Let us consider a simple kind of chemical reaction which can be written symbolically as:

$$A + B \rightleftarrows C + D$$

It is desired to convert substances A and B to substances C and D. What are the factors to be considered? The most important factors are: How much A and B goes over to C and D? How fast does it go? The amount of A and B that can go over to C and D is determined by the energy difference between the reactants and products.

The energy we are concerned with is known as "free energy," and it is usually represented by the symbol F. Any chemical reaction if coaxed properly will go to an equilibrium condition at which the free energy difference, ΔF, between reactants and products approaches zero. In other words, the driving force of the reaction becomes zero. The standard free-energy change, ΔF°, determines the equilibrium between reactants and products and is expressed arithmetically as follows:

$$K_p = PcPd/PaPb$$

$$RT \ln K_p = -\Delta F^\circ$$

Where R is the gas constant in cal./mole degree, T is temperature in degrees Kelvin, P's are the partial pressures of reactants and products, and K_p is the equilibrium constant.

This equation states that the greater the downhill free energy, the greater will be K_p and, in turn, the greater will be the yield of products at equilibrium. Chemical reactions are like water in that they will occur spontaneously only

Its Status Today and Its Promise for Tomorrow

when they go downhill in an energy sense.

These energy changes are of paramount importance in considering new reactions, for instance, the conversion of natural petroleum hydrocarbons into more desirable fuels and chemicals. It has only been in recent years that we have had accurate and plentiful information about the energies of the simpler hydrocarbons making up petroleum.

We still have a long way to go on the larger and more complex constituents in accumulating this energy information. In times past, such thermodynamic data were not available or were inaccurate so that much work was necessary to determine equilibrium concentration. Also, much useless work was carried out on reactions that later have been found to go uphill energetically.

"Spontaneous" reactions . . . It has been stated that it is necessary to have a decrease in free energy in order for our reaction to occur spontaneously. When we say "spontaneously," we mean that the reaction will occur by itself and approach its equilibrium in some time less than infinite time. In other words, we are saying that it is only theoretically possible for the reactants to go over into the products. Most chemical reactions which are thus spontaneously (or theoretically) possible occur slowly.

Some possible reactions do not appear to occur at all. For instance, diamond and graphite are different forms of the element carbon. Theoretically, from the free-energy change, diamond should revert to graphite. Fortunately, for the ladies and industry, this possible reaction does not occur at all. Some reactions do proceed almost by themselves. In this class are the explosives which need only more or less of mechanical shock to start them off. In general, chemical reactions occur slowly if uncatalyzed.

We now come to the importance of the catalyst which is defined as a substance which alters the rate of a chemical reaction, and it is not consumed or changed during the reaction. Usually, a catalyst is employed to speed up chemical reactions to the equilibrium condition, but we should remember, also, that catalysts can in some instances also slow down a reaction. Such a catalyst is referred to as an anticatalyst.

Kinetics of Reaction

For a chemical reaction, the rate of reaction may be expressed generally as:

$$\text{Rate} = k\,(C_1^{\,a}\, C_2^{\,b}\, C_3^{\,c} \ldots)$$

C_1, C_2, C_3, etc., are the concentrations of the reactants; a, b, c are constants; k is a rate constant and varies with temperature according to the Arrhenius equation $k = k_o e^{-(E/RT)}$ (for elementary rate controlling steps only); E is the activation energy.

The Arrhenius equation is only applicable to single steps in a reaction and not necessarily applicable to an over-all reaction system involving adsorption as contact catalysis always does. (For a discussion of the application of the Arrhenius law to catalytic reactions involving adsorption, see Reference 18.)

Potential energy . . . In Fig. 1 is shown a potential energy diagram of a system involving chemisorption and chemical reaction. Actually, this is a highly simplified pictorial representation of a reacting system. In any system of reacting molecules, various forces of attraction and repulsion will come into play as

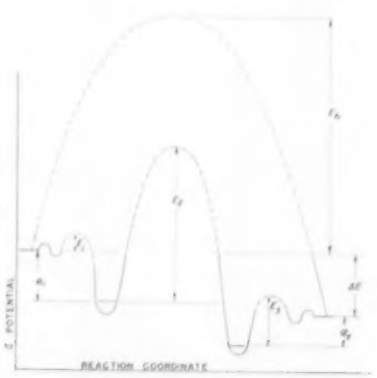


Fig. 1—Energy diagram showing steps in a reaction.

Meet the Author

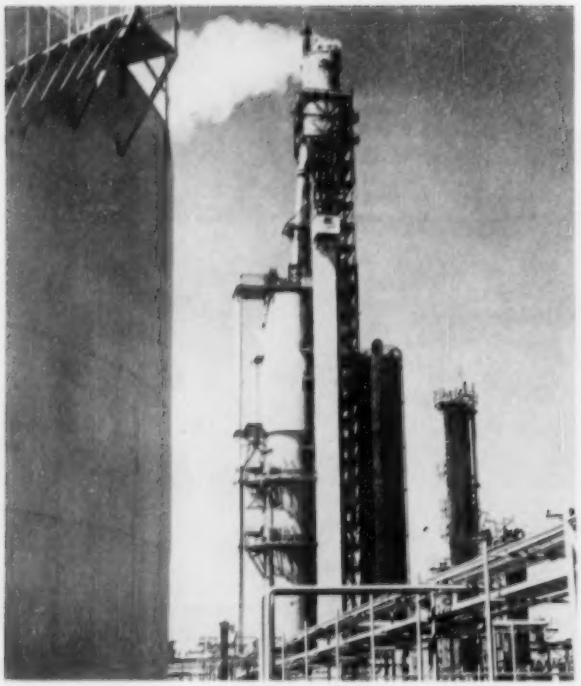
Alex Oblad is a man of many parts. He is a recognized authority on the subject he has undertaken to present on this comprehensive scale. His command of theory is balanced by a recognition of practicality. But his refusal to bow to expedient measures in research gives him the critical insight needed today if this industry is to get down to brass tacks on what makes catalytic processes work.

With many irons in the fire, he does not dodge adding more. And anyone familiar with the complexities of this subject will recognize that he has the ability to state what he knows, simply. These personal attributes made him the outstanding, and for us, the fortunate choice for this job.

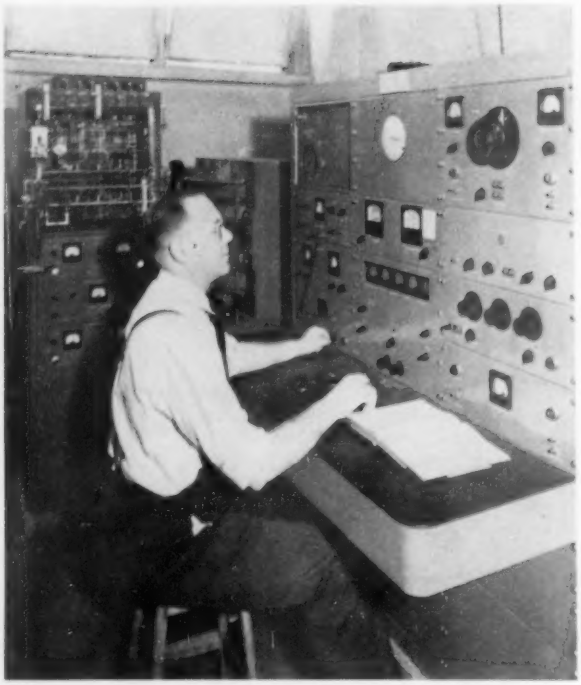
Dr. Oblad is associate manager of the research and development division at the Linwood Laboratories of Houdry Process Corp. Born in Salt Lake City, he received his B.S. in chemistry at University of Utah in 1933 and his master's the following year. Following a Ph.D. in physics and chemistry from Purdue University, he became a research chemist for Standard Oil Co. (Indiana). Between 1942 and 1947, when he joined Houdry, he was chief of chemical research in the field research department of Magnolia Petroleum Co. and head of industrial research with the Texas Research Foundation.

Next September he becomes chairman of the Petroleum Chemical Division, American Chemical Society. He holds more than a score of patents important in the field of catalysis, and is widely known for his contributions to fundamental chemistry, conversion of hydrocarbons and catalytic reactions. Dr. Oblad serves as a consultant to Catalytic Construction Co., a Houdry subsidiary, and has taken part in this company's atomic energy and petrochemical projects.

He has been secretary and chairman of the Catalysis Club of Philadelphia, and is a member of the Faraday Society, A.A.C.S., Sigma Xi, Phi Lambda Upsilon, and Sigma Pi Sigma. He is a member of the Church of Latter Day Saints. Dr. and Mrs. Oblad, the former Bessie Baker of Escalante and Provo, Utah, live with their five children in Springfield, Delaware County, Pennsylvania.



Gas produced in Houdriflow . . .



can be analyzed by mass spectrometer

the molecules approach one another. There will be a unique orientation of the molecules (activated complex) which allows a reaction to occur with a minimum of energy over and above that possessed by the reactants.

The minimum of energy is called the activation energy and is depicted by E_2 in the diagram. E_1 and E_3 are activation energies of adsorption and desorption, respectively. These energies are usually small.

ΔE is the heat of reaction of the system; e_1 and e_2 are heats of adsorption and desorption, respectively, and can vary between 8 and as high as 100,000 cal./mole. The small humps at the extremes of the diagram represent van der Waal's adsorption and may involve a small energy due to diffusion effects. E_h is the energy of activation for the homogeneous reaction to occur.

A catalyst increases the rate by greatly lowering the activation energy required for reaction. This means that the presence of the catalyst makes it possible for an activated complex (reaction intermediate) to be formed of much less energy than without the catalyst.

For a long time there was much discussion about whether catalysts can initiate reactions as well as accelerate them, Today such arguments are considered largely academic since the uncatalyzed analog of a catalytic reaction may require in certain cases infinite time for the reaction to occur. This case is defined as one having a very large energy of activation.

Catalytic Terminology

Sometimes it is possible to add to a catalyst an additional substance or substances which enhance the activity of the catalyst. This added substance is usually referred to as a **promoter.** On the other hand, certain other substances may subdue the activity of a catalyst. Such a substance is known as **poison.**

The important factors to consider about the catalyst itself are (1) activity, (2) selectivity, and (3) stability.

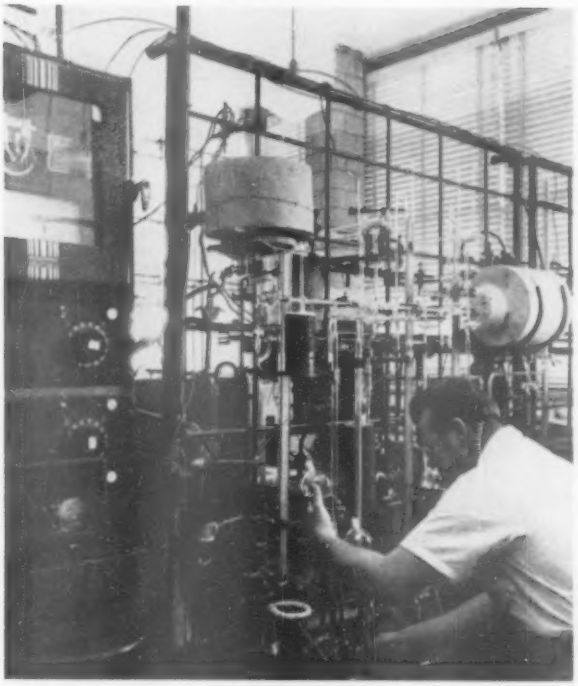
Activity . . . In practical catalyst work the activity is defined as the amount or extent of conversion per unit weight or volume of catalyst per unit time. This is not necessarily a true measure of intrinsic catalyst activity. Theoretically, activity is directly related to the specific rate constant k in the rate equation, but this is difficult to obtain because of many factors obtaining in a flow reaction (diffusional effects, mass flow effects, pressure drop, wall effects, etc.).

Selectivity . . . The selectivity of a catalyst is most important in catalytic chemistry. In theory we can talk about a catalyst and a single reaction, but in practice catalysts are not this simple and very often catalyze more than one reaction simultaneously. Selectivity is determined by the relative rates of the several simultaneously occurring catalytic reactions. A catalyst may catalyze a series of reactions starting with the formation of single activated complex which may react to yield several products; different kinds of sites may form several different activated complexes which yield different products; and, last of all, if more than one reactant is involved, interaction among complexes may yield several different products in addition to the products from the individual reactants. Industrial catalyst developments are obviously concerned with control of the selectivity factor.

Stability . . . The theoretical definition of catalytic action states that the catalyst ends up after the reaction without being changed. In actual practical catalysis, this is far from the case. The factors causing catalysts to change during the course of a reaction are:

1. Temperature alone or temperature changes during operation.
2. Pressure or pressure changes during operation.
3. Chemical reaction with reactants or products including materials inadvertently brought in with the reactants or substances formed during reaction. (In the latter instance, the effect is usually one of poisoning, although it is possible that in some cases promotion may result.)

A look at CATALYSIS



Catalyst surface properties are tested here . . . and the catalyst is used in reaction here

For convenience, catalytic action has been divided into classes depending on the physical state of reactant and catalyst. If catalyst and substrate are in the same phase (solid, liquid, or gas) the phenomenon is referred to as homogeneous catalysis, and if the phases are different, it is heterogeneous catalysis. Contact catalysis is another term used in the field to denote reactions involving solid catalysts and either liquid or gaseous reactants.

Early History of Catalysis

Now that we have our terms defined, let us proceed with a review of some of the history of the field of catalysis. It turns out that catalysis has been recognized only relatively recently. It was not recognized as such until 1835. Actually, catalysts have been servants of mankind since prehistoric times. Apparently, the first catalysis to be carried out, practically, employed enzymatically catalyzed reactions in the form of wine and vinegar manufacture. Likewise, the preparation of soap is a very old practice. These reactions involved the conversion of sugar to ethyl alcohol, ethyl alcohol into acetic acid, and fat into a salt of fatty acid and glycerol.

During the latter part of the eighteenth century, there was a great increase in the emphasis on chemistry, and it was natural that the influence of outside substances on chemical reactions was investigated. Between 1780 and 1835 many significant experiments were reported which described the effect of outside agents on chemical reactions. These experiments involved reactions induced by acids in solution, reactions in gaseous phase, and reactions induced by solids.

The means by which catalysts function was anticipated by Fusiniere (1825), who was first to consider the relationship between adsorption and what was later called catalysis. Faraday (1834) among others appears to have been aware that adsorption of the reactants played an important role in the induction of reaction by a solid. Clement and Desormes (1806) suggested that oxides of nitrogen played a role in the oxidation of sulfur dioxide through the formation of an intermediate compound.

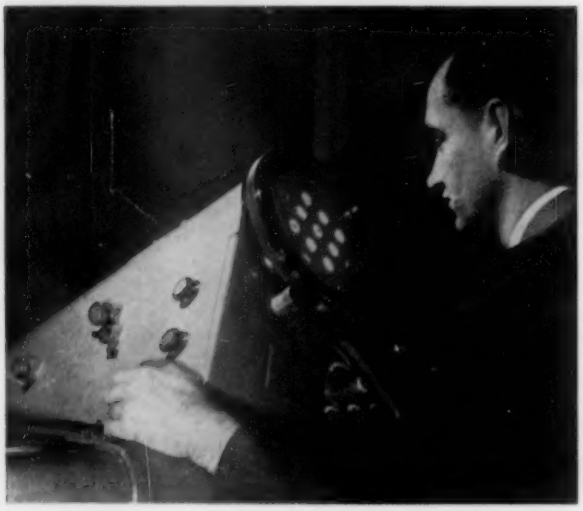
Many of the early experiments on catalytic action were done with some of the materials which are important today as catalysts in the petroleum industry, i.e., strong acids, clays, and metals such as platinum.

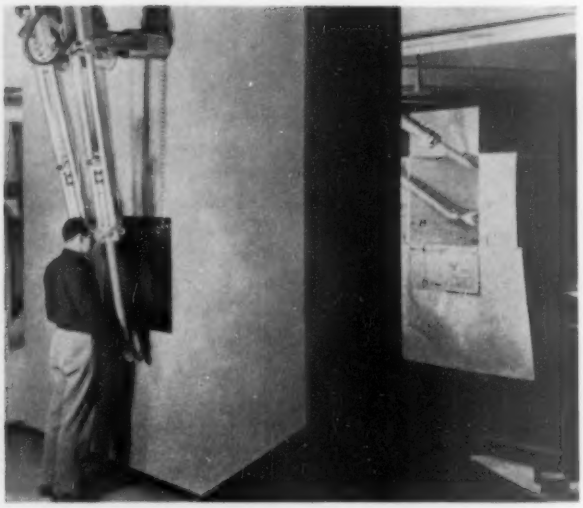
Berzelius named it . . . Berzelius,[1] one of the great organizers of chemical knowledge, was the first to see that these many divergent experiments of previous workers were generally related. In summarizing the then recent chemical work during the year 1835, he proposed for the first time that the many different experimental observations and results on reaction induction were generally related in that chemical reactivity could be induced by outside agents without the agents apparently taking any part in the reactions.

He called this general phenomenon "catalysis," taken from the Greek words for "down" and "loose." In this generalization, Berzelius introduced the concept of a "catalytic force," and, in doing so, apparently ascribed to matter a special kind of property or force which was able to bring about chemical reaction. This far-reaching concept, while not pin pointing the exact function of a catalyst, did draw attention to the interrelationship of a

"Theoretically, the catalyst ends up after the reaction without being changed. Actually this is far from the case. Three factors cause catalysts to change during the course of a reaction: temperature or temperature changes, pressure or pressure changes, and chemical reaction with reactants or products."

A look at CATALYSIS





Esso studies catalysts with electron microscope . . . and uses radiation to initiate reactions

large amount of apparently unrelated experimental facts.

Between Berzelius and the important contribution of Ostwald, the scientific part of catalysis marked time for about the next 60 years. This does not mean that there was little interest in the field. Liebig and others attacked the idea proposed by Berzelius of a special kind of catalytic force. There was other activity, but the next step taken by Ostwald had to be accomplished before any real significant new advances were made in catalysis.

During the 60-year perior, the work of Wilhelmy[2] (1850) and Bertholet and St. Gilles[3] (1860) stand out. Wilhelmy investigated the hydrolysis of cane sugar while Bertholet studied the hydrolysis of esters. Wilhelmy was the first person to appreciate the time factor in chemical reactions, and he, and later Bertholet and others, laid the groundwork for chemical kinetics as we know it today. The concept of the importance of time in chemical reactions had to be advanced before the next step in catalysis could be taken.

Ostwald measured it . . . In the latter part of the nineteenth century, Van't Hoff, Ostwald, Arrhenius, Hemholtz, and others were developing the field of physical chemistry in which for the first time the newer concepts of chemistry were reduced to quantitative laws. About 1902 or earlier, Ostwald[4] first recognized the true significance of the functioning of a catalyst. He defined a catalyst as a substance which alters the velocity of a chemical reaction without appearing in the end products. Ostwald's concept served to put catalysis for the first time on a measurable basis.

The science and technology of modern catalysis began at this time. Ostwald's succinct definition of catalysis dispensed with the Berzellian notion of a special kind of force being responsible for catalytic reaction. The advancements in practical catalysis since then have been tremendous until today the chemical and petroleum refining industries are based primarily on catalytic reactions.

Langmuir's work . . . Langmuir[5], between 1915 and about 1923, came out with a chemical theory of adsorption after studying reactions between gases and tungsten filaments in incandescent lamps. Langmuir proposed that because of the unsaturated chemical forces existing at the surface of solids, gaseous molecules hitting the surface would suffer inelastic collisions there and condense. See Fig. 2.

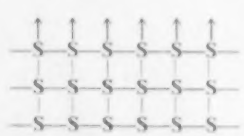


Fig. 2.—Diagrammatical sketch showing residual valence forces at the surface of a hypothetical solid. S's are the atoms or ions making up the solid lattice.

On this basis he developed a simple quantitative theory of the adsorption of gases and vapors by solids:

$$\theta = \frac{kp}{1 + kp}$$

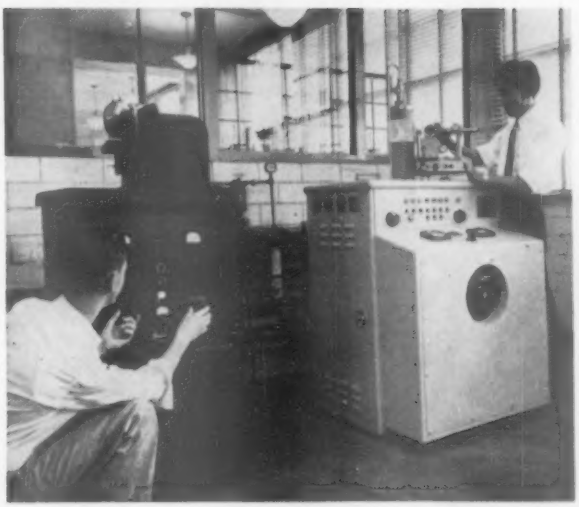
which relates the fraction of surface covered by θ (at equilibrium) to the pressure p of the gas being adsorbed. This equation is only applicable for the case where the surface of the solid is uniform (the energy of adsorption is constant) and impermeable and that the adsorbed species do not interact with each other.

Langmuir's contributions were widely accepted, and a great amount of effort was expended in obtaining experimental proof of his ideas. These studies of adsorption, however, made it evident that most catalyst surfaces do not adsorb gases in a manner that is energetically homogeneous as required by Langmuir's simple theory of adsorption. The adsorption by actual solids deviates from that predicted by Langmuir's theory much as actual gases do from the perfect gas laws.

Taylor's active centers . . . H. S. Taylor[6] made his first important contribution to the science of catalysis in 1925 when he proposed that surfaces of solids were not uniform and that the valence forces of solids producing Langmuir's unsaturated surfaces might be especially concentrated at the edges, points and prominences of the microscopic solid.

He proposed that the atoms or groups

"The discovery and isolation of the heavy isotope, deuterium, in 1932, provided a significant tool for the study of catalytic reactions . . . of very specific benefit to hydrocarbon reactions."



Houdry uses X-ray to find catalyst structure . . . then tests a charge stock in this pilot plant

of atoms at these discontinuities were especially active for adsorption and were thus active sites or centers. The concept of "active centers" has proved to be a basic one although the origin for these proposed by Taylor has subsequently been considerably modified.

The concept of active centers explains certain of the important chemical facts in catalysis which had become widely recognized, such as catalyst specificity and the effect of small amounts of materials in promoting or poisoning catalytic action. The ideas of Langmuir and Taylor added greatly to the program in understanding of catalytic chemistry. However, their ideas were speculative and qualitative and needed expansion and evaluation by further experimental and theoretical work.

Types of adsorption . . . About 1930[7] it was recognized that adsorption, which up to that time covered a wide variety of phenomena, could be divided into several types according to the energies involved in the adsorptive reactions; namely van der Waal's adsorption and chemisorption. Van der Waal's adsorption or physical adsorption encompass that kind of adsorption involving forces between adsorbent and adsorbate which correspond to those forces involved in the liquefaction of vapors. The energies involved are a few hundred calories at the most.

On the other hand, chemisorption is, as the term implies, associated with the formation of actual chemical bonding between adsorbent and adsorbate. The energies involved approach in size those actually occuring in chemical reactions, namely, 10-100 K.cal./mole. Physical adsorption is not important in catalytic action.

Eyring's theory . . . In 1931, Eyring[8] began publishing a theory of absolute reaction rates. An important aspect of Eyring's theory is the role of the activated complex in a chemical reaction. According to the theory, the activated state is of fundamental importance in that each and every molecule reacting must go through the activated complex form, the reactants being in statistical equilibrium with the complexes.

A key part of the theory is concerned with the structure of the complex and in particular the energies of the various chemical bonds in the activated complex. If the configuration of the complex is known, it is theoretically possible (although not practicable in most cases) to calculate the free energy of the complex.

The idea of intermediate compound formation between catalyst and reactant had been around for a long time. Eyring's theory served to focus attention on the activated intermediate itself and its importance in reaction kinetics not only in homogeneous uncatalyzed reactions but in addition for catalytic reaction.

The discovery and isolation of the heavy isotope, deuterium, in 1932, provided a significant tool for the study of catalytic reactions. This new tool[9] is of very specific benefit to hydrocarbon reactions since all reactions of these substances are intimately tied up with the activation and transfer of hydrogen. The availability of deuterium presented an opportunity for determining in a more definite way than before the interaction of hydrogen on catalyst surfaces and with the reactants undergoing changes. Since then, a great many other isotopes have been applied in catalyst studies in order to gather information on catalyst mechanisms. Prominent among these isotopes are O^{18}, C^{13}, C^{14}, and Cl^{35}.

Catalyst surface measurement . . . Solid materials acting as catalysts in heterogeneous reactions have been almost invariably materials of high porosity and large surface area. Quantitative assessment of specific catalyst activity requires a quantitative measurement of the specific catalyst surface. A method for the quantitative measurement of surface area was announced in 1938[10]. The extent of need of this procedure can be partially judged from the enthusiasm with which the procedure was adapted the world over. The number of publications concerned with surface area measurements employing the method is very large.

The method of Brunauer, Emmett, and Teller has had great utility in assigning a quantitative number to the surface area of solid heterogeneous catalysts and has contributed immensely to catalyst preparation, comparison, reproducibility, not only in a single laboratory, but among various laboratories working on similar catalysts. The part played by the physical properties of a catalyst in contributing to activity, stability, selectivity, etc., can be determined independently of the chemical properties by the BET method.

More recently the theoretical part of the BET method has been critically reexamined.[11] There are now some serious doubts about the validity of the original theory. In spite of these limitations, the BET method can still be relied upon to give a quantitative eval-

A look at CATALYSIS

uation of the relative surface area of various catalysts.

Catalytic Processes

1. Production of beverage alcohol by fermentation since prehistorical times.
2. Manufacture of soap since early times.
3. 1746—Lead chamber process for sulfuric acid.
4. 1872—Deacon process for elemental chlorine.
5. 1879—Polymerization of isoprene to rubber.
6. 1878—Synthesis of indigo.
7. 1900—Contact process for sulfuric acid.
8. 1908—Catalytic oxidation of ammonia.
9. 1913—Haber synthesis of ammonia from elements.
10. 1923—Synthesis of methanol from CO and hydrogen.
11. 1926—Bergius, coal hydrogenation.
12. 1927 - 1928 — Hydrogenation of petroleum (U.S.).
13. 1935—Fischer-Tropsch synthesis of hydrocarbons.
14. 1935—Ipatieff, polymerization.
15. 1936—Houdry, catalytic cracking.
16. Since 1936, alkylation, reforming, isomerization, synthetic rubber, dehydrogenation.

Present Status of Theoretical Catalysis

The technology of catalysis has proceeded at a prodigious pace in modern industry. The results have been achieved almost entirely on an empirical basis. Emphasis has been placed on determining by Edisonian methods what kinds of catalytic materials catalyze a given desired reaction.

Once a likely material has been found, then process data concerning temperatures, pressures, time of reaction, yields, and heat effects are determined. While such procedures are necessary to obtain specific process information, they contribute very little knowledge about how catalysts function.

The progress in the application of catalysis has therefore far exceeded the progress in understanding how a catalyst works. While this astonishing disproportion of progress between practice and theory is not unique to the catalytic field, in almost no field of science of equal importance is the situation so one-sided.

Chemists and engineers in industry as a matter of policy are much more interested in what catalysts will do than how they work. This is similar to the situation of money in human affairs. Most people are interested in what money will do for them, but not how it functions as a medium of commerce.

As tremendously important as catalysis is to modern industry, one is compelled to ask why this is so. There are many answers to this complicated question, and, perhaps, in the development of subject about to be presented, some of the answers will appear obvious. It is a tremendous task to make significant contributions to this very difficult field. One should point out that much of the empirical work has been published, and the results do provide gross chemical information on catalytic reactions.

No unitary theory . . . In spite of this large accumulation of experimental facts, it is not possible to explain in more than general terms the chemistry of catalytic reactions even today. It has been the ambition of chemists for decades to develop a unitary theory of catalytic action. The bias that such a hope has engendered in the thinking of chemists may be one of the reasons that success in explaining catalysis has been so slow.

It may turn out that the last great generalization about catalysis was achieved by Ostwald in 1902. Catalysis appears to be a very general property of almost all matter. Almost every simple chemical substance (solids, liquids, gases) can be made to catalyze some kind of a chemical reaction. Since a variety of materials of widely varying physical and chemical properties can perform as catalysts, obviously, therefore different and distinct mechanisms must be occurring in the broad field of catalysis.

Ultimately, we may be able to define catalysis in terms of, perhaps, no fewer than four or five distinct general concepts; this means that instead of a single unitary theory of catalytic action, we may end up with four or five. The vast amount of work in the chemistry of free radical reactions and homogeneous catalytic reactions and the physics and chemistry of the solid state, particularly the work being done in the field of semiconductors, corrosion, flotation, surface chemistry, structure of solids, and related aspects, is serving directly to help in understanding catalysis.

Where are we? . . . What do we really know about the mechanism of catalysis today, and where are we heading in this important field? What are the specific properties of a catalyst which account for its being able to accelerate a chemical reaction?

In summarizing this information I shall restrict my efforts to the field of heterogeneous catalysts. These are the catalysts which are important in the petroleum industry. The field of homogeneous catalysts is important also. A large part of this class is made up of the chemistry of the formation of high polymers such as synthetic rubber, polyethylene, plastics, and catalysis in solutions.

The role catalysts play in these reactions is much better understood than the role catalysts play in heterogeneous reactions. For the most part, catalysts in homogeneous reactions are concerned with the generation of the free radicals and ionic reaction intermediates. This is a vast field itself and could be the subject of a discussion as lengthy as this one is turning out to be.

Chemisorption

It is now generally accepted that chemical adsorption is a primary step in all catalytic reactions, and that specific chemical bonding exists between catalyst and reactants in the formation of activated complexes which are the reaction intermediates. Most modern ideas of catalysis start from this basis.

Progress made in the detailed understanding of the nature of chemisorption and its relationship to catalysis has only been of modest proportion since World War II. The theories of adsorption have been expanded and modified to account for the nonuniformity of surfaces. These modifications have grown in two directions; one based upon the assumption that actual heterogeneity of sites exists, and the other on the assumption that interactions between molecules makes for an apparent heterogeneity on a homogeneous surface.

The extent to which each of these two different concepts represents the true status of a catalyst surface is still being actively debated, and rather com-

"Chemical adsorption is a primary step in all catalytic reactions and specific chemical bonding exists between catalyst and reactants in the formation of activated complexes which are the reaction intermediates."

plicated experimental procedures involving isotopic mixtures have been and still are being carried out to determine the amount of truth in each proposal.

System deviations . . . As has been pointed out previously, Langmuir's theory was based on a set of idealized conditions which apparently never actually obtain in any real system. Every real system deviates from this ideal case, and many attempts have been made to explain the deviations. In many cases, the experimental data on adsorption can be correlated on the basis of the Freundlich[12] equation:

$$V = k\, p^{(1/n)}$$

Where V is the volume adsorbed per unit weight of solid, p is pressure, and n is a number usually greater than 1. This equation is empirical and has no direct theoretical justification. (It predicts infinite adsorption at infinite pressure which is an obvious fallacy.)

Langmuir[13] in one of his early papers has examined the case of adsorption on a series of sites of varying activity. He proposed the following equation for the isotherm in this case:

$$\Theta = \sum_i \frac{k_i p}{1 + k_i p}$$

Recent developments . . . Recent work in the field of chemisorption has been, for the most part, concerned with the implications of applying this equation to actual experimental data.[14 15 16 17] For this, it is necessary to know (1) the distribution of sites, is it continuous or otherwise, and how is the number of sites related to the energy of adsorption and (2) the parameters for each kind of site. Deductions have been made of these unknowns from given isotherms and, conversely, various distributions of sites have been tried arbitrarily in order to make the calculated isotherm fit the experimental isotherm.

The most important finding from these various studies is that the Langmuir equation reverts to the Freundlich relationship when a nonuniform surface is assumed in which the distribution of sites is an exponential function of the energy of adsorption. The mathematical treatment of chemisorption on a heterogeneous surface is quite complex even when not taking into account the adsorbate interaction on the surface, and much work still remains to be done in order to understand thoroughly even simple adsorptions.

The more complicated situation wherein adsorbate interaction and multiple adsorption, including dissociation of adsorbed molecules and mobility, has been studied little. Such situations need to be understood before it will be possible to put chemisorption and its relationship to catalysis on a firm quantitative basis.

"Rates of most catalytic reactions are controlled by chemical reaction occurring on the surface of the catalyst and not by diffusion of the reactants to the catalyst sites nor by rates of adsorption of the reactants nor by the desorption of the products."

Kinetics

The previous discussion was concerned primarily with a brief presentation of the status of our knowledge of the phenomenon of the chemical interaction of solids with gases. Statement was made that chemisorption always appears to precede catalytic action and is a necessary prerequisite for this to occur. The bulk of the proof of the relationship between chemisorption and catalytic action arises from the interpretations of the kinetics of surface reactions based on the laws of chemisorption which have been reviewed.

We have seen that catalytic reactions actually occur by a series of simple steps. Experimental evidence shows that the rates of many catalytic reactions are controlled by chemical reaction occurring on the surface of the catalyst and not by diffusion of the reactants to the catalyst sites nor by rates of adsorption of the reactants nor by desorption of the products.

Surface reactions . . . Much theoretical work has been done in setting up the kinetics of surface reactions wherein the surface concentrations of reactants is taken from Langmuir's adsorption law, for example:

$$\text{Rate} = k_1 \Theta$$

$$\text{Rate} = \frac{k_1 kp}{1 + kp}$$

Such derivations are straightforward in the simple cases wherein as before the surface is considered to be homogeneous and adsorbed species do not interact.[18] Many variations of reactions involving both one or two reactants including, among others, strong adsorption of one or more reactants, weak adsorption of one or more reactants, strong adsorption of the product, etc., have been studied.

The agreement between predicted rates and experimental rates appears to be fair in many cases. In view of the fact that these rates are based on idealized chemisorption, it is surprising that the agreement is as good as it is with experimental results, considering that most solid catalysts appear to have nonhomogeneous surfaces. In any given catalytic reaction it is very probable that not all chemisorbed species on the catalyst surface enter into the reaction.

Surface requirements . . . Chemisorption[19] may frequently involve a large part of the catalyst surface under the condition of the reaction being carried out. Catalytically reactive chemisorbed molecules may consist only of a small fraction or band of the adsorbed species, particularly those on the most active of the active centers. This means that only a very small spectrum of the surface is doing most if not all the catalytic work. Since a catalyst cannot alter the equilibrium of a reaction, the free energy balance requires that all the steps of the catalyzed reaction must balance the over-all free energy of the uncatalyzed reaction.

In effect, this amounts to the reactants in a catalytic reaction picking out an "adsorption band" which is narrow and fits in with the energy balance requirements. If the band is quite narrow, the sites involved will be essentially homogeneous and thus adhere to the requirements of the simple Langmuir theory.

Nonidealized surfaces . . . The kinetics of reaction on active nonidealized surfaces have been studied[20 56 57] by a number of people. The factors already discussed which complicate chemisorption on a nonidealized surface will enter into the kinetic consideration also since surface concentrations are derived from the laws of chemisorption.

The treatment of this subject is complex and will not be discussed in detail here; however, the results show that in many cases even on nonidealized surfaces only a narrow band of active centers is involved in catalytic reaction. Kinetic analysis may be complicated additionally in complex reactions where more than one step may be slow and contribute to control of the over-all reaction.

Even simple homogeneous reactions are not thoroughly understood in a kinetic sense and for catalytic reactions we have superimposed upon this the complexity already discussed in connection with chemisorption. Obviously, much remains to be accomplished in this area of catalysis.

Rate limitations . . . Unfortunately, the

limitation of the rates' laws based on the simple Langmuir type adsorption are not always appreciated by workers in the catalytic field. Too often we find in the literature, applications of rates' laws based on simple Langmuir adsorption law to a particular reaction under study. The investigators are often led into believing that the interpretation is correct simply because the applied equation appears to fit the experimental data obtained. Usually the applied equation will have several constants which when empirically evaluated will be sufficient to get a good correlation.

Often there is no theoretical justification for such a correlation, however, since there are many other expressions having the same number of constants which will fit the data just as well or even better. Among the latter is the use of the Freundlich equation from which is obtained the surface concentration of reactants:[21]

$$\text{Rate} = k_1 k_2 \, p_a^{(1/n_a)} \, p_b^{(1/n_b)}$$

Nature of Active Centers

General

No one knows yet what the surface of a catalyst is like. In developing ideas of the surface we have had to rely upon extrapolation of the properties of bulk materials which can be studied by X-rays and other ways. Catalytic chemists have assumed that the composition, structure and stability of the bulk material extends right out to the surface.

In any discussion of the surface we should not forget that there is evidence for mobility of the surface atoms of solids, that surfaces are exceedingly difficult to make pure, that the surface is under great mechanical strain, and that the chemical and physical properties of the surface can be greatly different from those of the bulk material. Solid catalysts are probably crystals in bulk even though X-ray studies cannot detect structure. With these suggestions in mind, we shall now discuss briefly the nature of active centers.

Active centers . . . We have mentioned "active centers" a number of times without really saying much about what these sites are like. The evidence for the variability of a surface of a solid in its ability to adsorb gases and to catalyze reactions is:

1. The variability of the measured heat of adsorption of a gas with surface coverage.
2. The ability of a surface to adsorb different gases in different amounts even to the extent that one gas will not displace another.
3. The selectivity of solids in their ability to catalyze chemical reactions.
4. Poisoning of catalysts: very small amounts of foreign substances sometimes vastly alter the ability of a solid to catalyze a given reaction; poisoning effect is generally not a linear function of poison concentrations; poisoning of catalysts is often very selective in that small amounts of a poison will alter the ability of a solid to catalyze one reaction, but not another.
5. The known variability of adsorptive power and catalytic ability of a solid as induced by preparative procedures. It is a well-known fact that adsorbents and catalysts are difficult to reproduce from batch to batch unless extreme care is used in preparative steps.
6. Promoter effects: the sensitivity of catalysts to small amount of certain foreign substances which enhance the catalytic activity.
7. The results of the analysis of the experimentally determined rates of surface reactions and experimental adsorption data in terms of the simple Langmuir theory.

Our knowledge of the surface is still in a very elementary state. The kinds of surface discontinuities proposed by Taylor in 1925 undoubtedly play a part in the heterogeneity of the surface, but such irregularities are not the fundamental cause of active centers.

Surface variability . . . In the concept of variability of a solid surface, we have several factors to consider, namely, the number of active sites per unit surface area and for chemisorption, the energy distribution of the sites and for catalysis, the distribution of catalytic activity (reaction velocity) among the sites. For instance, in an active cracking catalyst,[24] the total number of sites active for the cracking of cumene is about 3.6×10^{19} sites per gram or about 1.2×10^{17} sites per square meter.

This number of sites actually occupies about 4 per cent of the surface of the catalyst. This and much other similar evidence strongly indicates that for catalysis in general, excluding pure metals, the occurrence of an active center is a rare or somewhat unusual phenomenon. To obtain a sufficient specific concentration of sites necessary for a high catalytic activity, preparative methods for catalysts usually are chosen on the basis of extending the surface of a given weight of catalyst as much as is consistent with the other catalyst requirements such as temperature stability, mechanical strength, cost, etc.

Atom arrangement . . . In recent years as a result of some very careful work on highly purified metallic catalysts, Beeck[25] and his coworkers showed that for metals the geometrical arrangement of the atoms in a particular crystal face is critical in determining catalytic activity. Based on this work and the work of Roberts,[26] Rideal,[27] Eyring,[28] and Balandin,[29] it became fashionable to explain catalytic activity of metals in terms of a one-to-one arrangement of at least one of the reactants with the atoms in the catalyst, activity being greatest on those crystalline faces of the catalyst having an optimum interatomic distance.

A well-ordered crystalline array is a necessary requirement of this theory, and it is therefore at variance with the accepted concepts of active centers. In pure metals as opposed to other varieties of catalysts, the evidence shows that every atom in the surface is active in chemisorption.

On the other hand commercial metal catalysts appear to be heterogeneous in that active centers seem to be present. These two contraindications of metal catalysts require more definitive experiments to establish the role played by impurities, pore size, and lattice discontinuities in generating apparent heterogeneities on a metal surface.

Activity factors . . . The geometrical explanation as the principal factor in catalytic activity has been questioned in very recent years largely as a result of the increase in the knowledge of the solid state. The correlation of interatomic distances of various metal catalysts and ethylene hydrogenation activity which was the basis of the geometrical hypothesis has been superseded on a more fundamental basis by a correlation of activity with the electronic structure of metals.[30 45 46 47]

Pauling[31] has shown that metallic radii of various metals are a function of the bonding character of the metallic state. Hence, the definite crystalline array is not the seat of catalytic activity, but along with catalytic activity is

"Catalysis appears to be a very general property of almost all matter. Almost every simple chemical substance (solids, liquids, gases) can be made to catalyze some kind of a chemical reaction."

an effect of the specific electronic properties of the metals.

Electron arrangement . . . Any final successful theory or theories of catalytic activity must be concerned with the specific arrangement of the electrons between catalyst and reactant. The nature of the chemical binding of chemisorbed species and the activated complex must be established. Is the binding of ionic or covalent character? This has recently received a great deal of consideration in connection with various kinds of catalysts. Dowden[32] has classified heterogeneous catalysts into three classes:

1. Conductors (metals).
2. Semiconductors (oxides, sulfides, hydrides).
3. Insulators (oxides, strong acids).

This particular classification implies that a relationship exists between the capacity of a material to act as a catalyst and its ability to conduct an electric current. No direct correlation between catalytic activity and conduction has yet been established although proponents for this idea are very active today, particularly on oxide semiconductors. This classification while satisfactory from the point of view of solid state physics, particularly as applied to solid catalysts, does not emphasize the chemical aspects of catalysis and does not include important strong acid catalysts.

From the standpoint of the chemist, a preferred classification of catalysts is:

1. Strong acids and bases.
2. Metal oxides, sulfides and hydrides.
3. Metals.

Strong Acids and Bases

In the whole field of catalysis probably more is known about the functioning of strong acids than any other class of catalyst. In this class fall sulfuric, phosphoric, and hydrofluoric acids, aluminum halides, boron trifluoride, silica-alumina, and many other acid substances of lesser industrial importance.

The attainment of the present level of knowledge in this field has been greatly aided by appropriation of concepts and accumulated information from the field of solutions and homogeneous liquid phase acid-base catalyzed reactions. Concepts borrowed are those concerned with Bronsted and Lewis acids and bases and the ionic mechanisms proposed for homogeneous reactions, particularly the hydrolysis of esters, sugars, fats, and other organic compounds.

Only recently have the widely varying materials making up this class of catalysts been brought to a common basis and the reaction they catalyze been brought to a common mechanism. In reactions important to the petroleum industry today, the strong acids were first known to dehydrate alcohols and polymerize olefins.

Whitmore[33] (1932) first proposed an ionic mechanism for the polymerization reaction. From this time on, gradually and dramatically the great importance of hydrogen ions (protons) and the carbonium complex mechanism of reaction has been extended to include many catalysts and reactions until today even solid catalysts such as silica-alumina have finally been established as strong-acid catalysts.

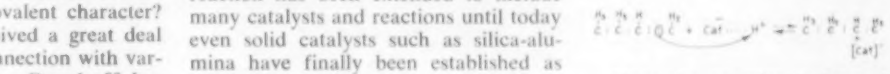
Acid catalysis . . . As far as the study has been carried, all the strong-acid catalysts catalyze the same series of reactions varying only in degree of activity and not kind. Such a conclusion is not as far reaching as it appears to be since some of the reactions are the reverse of others. For instance, cracking is the reverse of polymerization and alkylation. A catalyst always is capable of catalyzing a reaction in both directions.

Some strong acids apparently don't catalyze certain reactions of the class. However, this is due to decomposition of the acid or some other similar complicating chemical factor. As an example of this, sulfuric and phosphoric acids don't appear to crack hydrocarbons. The reason such acids do not catalyze cracking is that at cracking temperatures, these acids are not stable.

There are thus great similarities among the members of this class of catalysts. However, mechanistically the formation or constitution of the active centers (or species) varies. Fundamentally, all the catalysts in one way or another can donate and accept protons; proton transfer is, therefore, an attribute of these catalysts, and it plays a most important part in the reaction mechanisms. Another similarity is the requirement of an unsaturated species of reactant in the sequence of reaction steps.

Carbonium ion complex . . . As a common mechanism, all strong-acid catalyzed reactions involve a carbonium ion complex as intermediates. The term "ion" is a misrepresentation in the sense that carbonium ions are not to be visualized as free ions ordinarily believed to exist in dilute solutions. A truer visualization is to think of such particles as highly polarized complexes, the parts of which are held together by strong electrostatic forces (ionic bond).

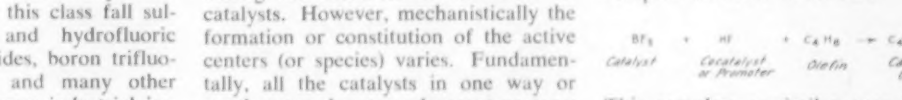
The complex is formed by the addition of a proton from the catalyst to a free electron pair existing in the organic substrate. (The proton becomes bonded in the case of hydrocarbon reactions to the extra electrons in the olefin or aromatic molecule.) Diagrammatically this reaction can be represented as follows:



Once the complex is formed as represented, it can, depending on reaction conditions, undergo changes within itself or react with many other molecules to accomplish isomerization, cracking, alkylation, polymerization, hydrogen transfer, cyclization, etc. Each one of these reactions involves many steps as will be shown later.

Proton origin . . . The origin of the proton in the strong acids such as sulfuric acid, etc., is readily explained. However, it is not so obvious in the case of the boron and aluminum halides and silica-alumina.

For boron trifluoride, aluminum halides, and other active halides, an extraneous source of protons must be made available in order to induce catalysis by these substances. The source is usually water or hydrogen halides, but it can be a number of other materials. These catalysts form the carbonium complex therefore as follows:



This complex, or similar ones, is capable of undergoing all the previously mentioned reactions.

Silica-alumina . . . The solid materials such as silica-alumina are much more complicated than the two previous groups of strong-acid catalysts. Silica-alumina can be demonstrated to have acidic properties by the usual tests for acids, namely, reaction with inorganic bases, carbonates, volatile bases such as ammonia and organic nitrogen compounds, hydrolysis of sugars,[39] etc. Furthermore, its activity as a catalyst can be correlated with its measured acidity.[39]

"The vast amount of work in the chemistry of free radical reactions and homogeneous catalytic reactions and the physics of chemistry of the solid state is serving directly to help in understanding catalysts."

A look at CATALYSIS

"In the whole field of catalysis probably more is known about the functioning of strong acids than any other class of catalyst. In this class falls sulfuric phosphoric, and hydrofluoric acids, aluminum halides, boron trifluoride, silica-alumina, and many other acid substances of lesser industrial importance.

"The attainment of the present level of knowledge in this field has been greatly aided by appropriation of concepts and accumulated information from the field of solutions and homogeneous liquid phase acid-base catalyzed reactions."

It is generally agreed that the origin of the strong acid in silica-alumina is a cation defect.[39 40 41] Silica has a crystalline arrangement involving a silicon ion, is four-coordinated, and as a result is surrounded by four oxygen ions at the points of a tetrahedron. The oxygen ions are shared by two tetrahedrons to bring about neutrality of charge.

Placing alumina in the immediate ionic environment of silica makes the alumina take on the same type of structure as the silica, namely, a tetrahedral structure surrounded by four oxygen ions. Normally, an aluminum ion wants to be six-coordinated and surrounded by six oxygens in an octahedral arrangement.

This forced transition from a normal six-coordinated state to a four-coordinated state results in a net surplus of one electron for each alumina tetrahedron and a resulting negative charge on the anion. There now exists a cation deficiency or "defect" which must be supplied in the form of a cationic particle.

Hydrogen ions present as residual combined water or protons from other sources can fill the requirements and when the combination occurs, a strong acid catalyst results. If we replace the proton by sodium or ammonium ions or other cations, we have the well-known base exchange phenomena occurring. The resulting material is of course then not a catalyst.

Exactly how this strong acid comes into being and its detailed structure are controversial points at this time.[39 40 42]

Gamma alumina, silica-magnesia, silica-zirconia, and related compounds resemble silica-alumina in properties. How the cationic defect structure arises in these substances is not known.

Base catalysis . . . The analogous system of base catalysis has been long in developing. These systems for other than polymerization of butadiene and styrene using sodium and sodamide have been studied very little. Recently, Pines et al.[43] has discovered a very interesting new reaction involving promoted sodium metal as a catalyst for the side-chain ethylation of alkyl aromatic hydrocarbons. These reactions are believed to occur by the acceptance of a proton by catalyst from the reactants.

From theoretical principles, base catalysis has many possibilities in hydrocarbon chemistry and ultimately may be important. It is an open field for future work.

Metal Oxides, Sulfides, Hydrides

These materials as a group form a transition between acid-base catalysts and metals. We say transition because metal oxides, etc., have some of the properties of each of the two other groups. They are known as hydrogenation-dehydrogenation catalysts and on the other hand appear to have acidic properties catalyzing such reactions as cyclization, cracking, and isomerization. In addition, they are oxidation and dehydration catalysts.

The active centers of this group of catalysts must be at least of two kinds. The acid-like sites probably originate through cationic defects induced by changes in coordination and valence of the metal ions. Such things can come about by changing the state of oxidation of the metal ion. These materials as a class form a wide variety of heteropoly acids which are well known in the field of modern inorganic chemistry.

The oxidation activity of the metal oxides of this group can be related to oxidation-reduction states of the oxide[19] or in other words to the presence of two valence states not far apart in energy which allows oxygen to be activated in the oxidation step and released in the reduction step.

Metallike properties . . . The hydrogenation-dehydrogenation or metallike activity of metal oxide has been related to their metallike conducting properties. Many of the metal oxides which are catalysts are also the semiconductors of the physicists. They are not as good conductors of electrons as metals and unlike metals, their conductivity increases with increasing temperature. They are not as active for activation of molecular hydrogen nor hydrogenation as metals. The theory for accounting for the electronic properties of these metal oxides and sulfides has been pretty well worked out.[44]

The conductivity is related at a given temperature to the presence and extent of defects in the crystal lattice. The oxides and sulfides of this class are ionic solids which by temperature alone or chemical means (reduction or oxidation) become nonstoichiometric. As a result, excess of metal or oxygen occurs in the lattice and the points of these excesses are defects. Defects can also be introduced by purposely introducing impurity metal atoms of different valence than the principal cation or anion.

The presence of these defects alters the electronic energy levels within the solid so that some of the electrons can by thermal excitation be mobilized and hence contribute to conduction. Depending on the kind of defects present, the solids are able to accept, denote, or share electron with a substrate. In order for it to do this, the solid catalyst crystallite must have electrons or places for electron available to the adsorbing molecule.

The energies involved in these interactions must be modest in size in order for catalytic action to occur. It is these particular electronic properties which have been proposed for chemisorption and the metallic-like catalytic activity of these oxides.[32]

Water's part . . . Another facet of the catalytic properties of metal oxides is the part played by water. Many of the metal oxides require activation by heating as a final step in their preparation. The terminal structures at the surface are OH groups rather than oxygen ions. Heating decomposes these surface hydroxyls and water is lost.

The resulting oxide structure on the surface is in a strained condition making it a catalyst for certain reactions such as alcohol dehydration and possibly H_2—D_2 exchange. Because of the potential to form hydroxyl and its polar properties, small amounts of water have a very pronounced effect on many oxide catalysts.

". . . evidence strongly indicates that for catalysis in general, excluding pure metals, the occurrence of an active center is a somewhat unusual phenomenom."

A look at CATALYSIS

Metals

As is the case with metal oxides, catalytic properties are being defined and correlated in a very general way with the electronic properties of the metals. The structures and some of the properties of metallic solids are now fairly well understood. Included are these properties:

1. Cohesive forces holding crystal together.
2. Electrical and thermal properties.
3. Magnetic properties and optical properties.

The application of electron theory to metals has been quite successful. This theory is based on the assumption that within the solid the electrons are subjected to a periodic potential provided by the solid cores of the crystal lattice. The motion of the electrons is quantized. The principal industrial metallic catalysts are found in Group VIII of the periodic table and are therefore transition elements having almost full or completed, 3d, 4d, and 5d electron orbitals.

According to the band theory, the transition elements have vacancies in the d series of electron energy levels (d-band) and these holes have been proposed as the seat of activity for the Group VIII metals.[30 45 46 47] The idea of "vacancies" or "holes" implies that electrons from adsorbing molecules can fill these vacancies and thus make a chemical bond. A transfer of electrons would lead to an ionic-type bond whereas a sharing of electrons between orbitals of the metal and those of the adsorbing molecule leads to a covalent-type bond. There is some evidence to show that the bond is largely covalent for hydrogen on chemisorbed transition metals.

Metallic state . . . Pauling[31] has developed a theory of the metallic state which is based on electron pair bonds between atoms. There are not enough pairs to go around to all neighboring atoms so the bonds are pictured as resonating between positions among nearest neighbors. The electron pair bonds in the transition metals are made up of electron occupying hybrid 4d, 5s, and 5p orbitals. All the d orbitals are not used up in the bonding and are therefore available as atomic orbitals, i.e., they are available to a substance being adsorbed.

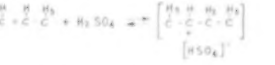
Both the free electron band theory and the valence bond theory of Pauling when applied to catalysis at present require that the energies levels or the orbital hybridization of the bulk metal extend right out to the surface. That such a situation exists has yet to be established.

Mechanism of Catalytic Reactions

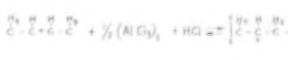
Strong acids . . . All the catalysts in this class are generally believed to act through the same kinds of reaction mechanisms. The catalysts may differ in the way the carbonium ion complexes are formed, but once these intermediates are formed the same kinds of reactions usually involving a chain mechanism take place. The dielectric properties of the strong acid catalysts are such that the highly polarized complexes can be formed. A closely related requirement is that of hydrogen ion mobility. The principal steps in all carbonium ion reactions of hydrocarbons are:

1. Formation of the carbonium complex.
2. Reaction of the carbonium complex by transfer of a proton, alkyl, or alkyl group; addition of an olefin or decomposition.
3. Destruction of the carbonium complex by intermolecular transfer of proton or hydride ion.

The carbonium ion complex can be formed in many ways depending on the nature of the reactant hydrocarbon and the catalyst. For the strong acids, the origin is readily explained when the charge contains olefinic or aromatic hydrocarbons. In this case the reaction is simple:



Metal halides . . . When the catalyst is an aluminum or boron halide, it is necessary along with olefins to have small amounts of hydrogen halide present as mentioned previously to form the complex:



The strong acids H $AlCl_4$ and H BF_4 do not exist; hence, some source of hydrogen halide must be present in order for the reactions to occur. Traces of water, oxygen, halogen, alcohols may under varying circumstances act as a source of protons for these catalysts. The importance of hydrogen halide as a cocatalyst for Friedel-Crafts catalyst has only been appreciated in recent years.[35 36 37 38] Great care has to be taken to exclude traces of water, oxygen, etc., in making the definitive experiments to prove the need for hydrogen halide.

Earlier workers always inadvertently included such materials, so that the need for such was not detected nor understood. The need for a cocatalyst has been established even in certain instances where its presence resisted detection for many years, i.e., olefin polymerization to high-molecular-weight materials such as isobutylene into polyisobutylene as catalyzed by boron trifluoride or aluminum chloride.

Olefin needed . . . Likewise, the presence of at least a small amount of olefin in strong-acid catalyzed reactions of saturated hydrocarbon molecules is now believed to be necessary. The need for such has been unequivocally established for paraffin isomerization.[35 36]

In cracking,[34] it is more difficult to prove the need of olefin to initiate the reaction. Enough olefin can be formed by thermal reaction or by the interaction of the hydrocarbon with the highly strained catalyst surface in the case of silica-alumina. Once the reaction is under way there will be ample olefin to keep it going since olefins are important products in catalytic cracking.

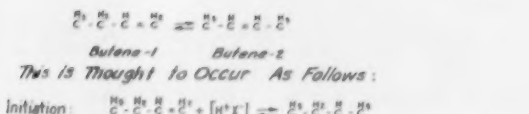
The mechanisms of the principle simple hydrocarbon reactions are depicted schematically in the following paragraphs.

Isomerization . . . There are two types of isomerization reactions to be considered.

1. Double Bond Isomerization in Olefins

The simplest reaction of all in the carbonium complex system of reactions is the migration of a double bond in a molecule:

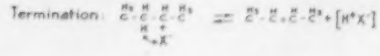
"Present techniques need to be refined to obtain more definitive data. A more critical interpretation of the data is also required. Kinetic and thermodynamic data of proper definition can shed much light on the nature of the chemisorbed and the activated species involved in catalytic reactions."



This Is Thought to Occur As Follows:

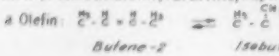
Initiation:

Termination:



3. Methyl Shift in Olefin, Paraffins, Naphthenes, and Aromatics

a. Olefin:



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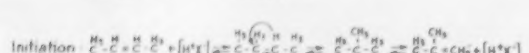
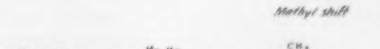


b. Paraffins:



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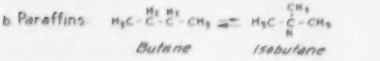
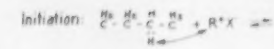
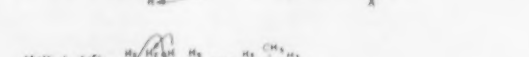


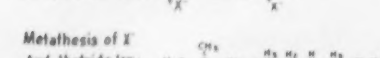
Methyl shift:



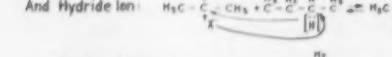
Metathesis of X⁻ And Hydride Ion:



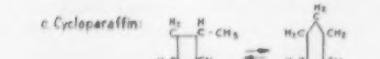
c. Cycloparaffin:



Initiation:



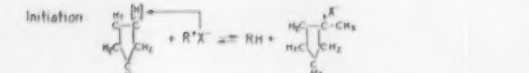
Methyl shift



Metathesis of X⁻ And Hydride Ion

d. Aromatic:

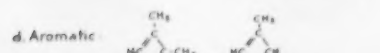
Initiation:



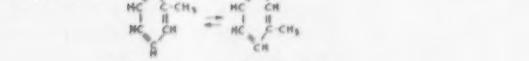
Polymerization:

Initiation:

Addition:



Termination:

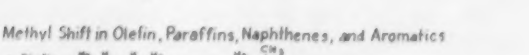


Alkylation:

Initiation:

Addition as in Polymerization:

Metathesis of Hydride Ion and X⁻

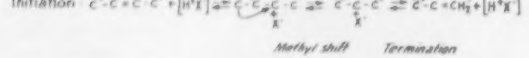


Cracking (reverse of polymerization and alkylation)...

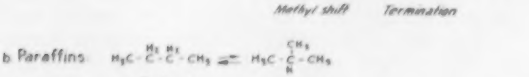
1. Paraffin:

Initiation: (Metathesis)

Rupture:



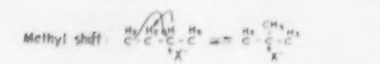
Termination: (Metathesis)



2. Olefin:

Initiation:

Rupture:

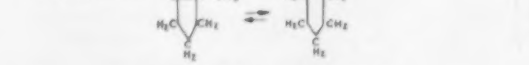


Termination:

3. Alkylaromatic:

Initiation:

Rupture:



The chemistry involved in the commercial isomerization,[48] cracking,[49] alkylation,[50] polymerization,[51] etc., is much more complex than that given in the simple reactions outlined in the previous paragraphs. The complexity is brought about by the simultaneous occurrence of many of the reactions described in a single process. For instance, in catalytic cracking, all of the reac-

tions occur to some extent. In this process and others there are still other reactions such as cyclization and hydrogen transfer which occur.

These reactions lead to the production of unsaturated cyclic substances in the low-temperature processes such as polymerization, alkylation, isomerization, and aromatic hydrocarbons and coke in catalytic cracking. The mechanisms of these latter reactions are more conjectural at the present time although they are thought to occur by steps which are similar to those already described.

Metal Oxides, Sulfides

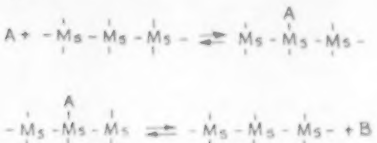
Very little is known regarding the mechanisms of reactions catalyzed by this group of catalysts. Because they have such a wide range of chemical properties, these catalysts appear to catalyze many of the reactions catalyzed by strong acid, particularly those that appear to be readily catalyzed by strong acids such as double-bond migration, cyclization, and skeletal isomerization of olefins. In addition to this activity, the metal oxides can dehydrogenate, depending on the temperature: paraffins, olefins, and naphthenes to yield olefins, diolefins, and aromatic hydrocarbons.

Because of this multiplicity of reactions that can take place simultaneously over metal oxides, the mechanisms of reactions are very difficult to study. The strong-acid active centers certainly may catalyze reactions by means of carbonium complexes. Still other kinds of centers must be concerned with the transfer and release of molecular hydrogen. Obviously, much remains to be learned about the nature of the active centers and mechanisms of this class of catalysts. The mechanisms about to be described for metals probably apply as well for metal oxides.

Metals

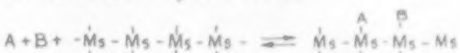
The mechanisms of metal catalyzed reactions of even exceedingly simple reactions such as para-hydrogen-ortho-hydrogen conversion, hydrogen-deuterium exchange, and ethylene hydrogenation are only partially understood. The more complicated reactions such as ammonia synthesis, naphthene dehydrogenation-aromatic hydrogenation, aromatic nitrocompound reduction, etc., are in a state of almost pure conjecture.

Hinshelwood[52] employing Langmuir's concepts of catalytic reactions has proposed a mechanism for reactions in which the reactant molecules are chemisorbed on the surface of the metal as atoms or radicals. Where only one reactant is involved the reaction can be represented schematically as follows:

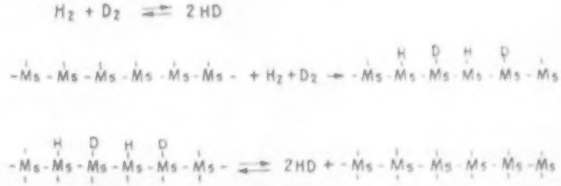


where A is the reactant, M_s is a metal site on the surface of the catalyst.

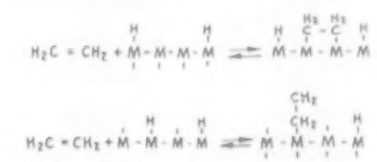
For a bimolecular reaction between two reactants, reaction is thought to occur between two adsorbed species which are contiguous to each other in the chemisorbed layer as follows:



For hydrogen - deuterium exchange the reaction is as follows:



Olefin hydrogenation . . . For olefin hydrogenation, the mechanism can involve two-point adsorption of ethylene or single-point as follows:



The Langmuir-Hinshelwood mechanism is generally accepted to occur in most metal and metal oxide catalyzed reactions today although the exact nature of the adsorbed species for even simple reactions is pretty much of a mystery in both metals and metal oxides. In recent years there has been some tendency particularly for reactions involving two reactants to revive an early proposal of Langmuir that of reaction between an adsorbed species and a reactant in the gas phase or in a physically adsorbed state.[47 53]

It was pointed out previously that for a catalytic reaction all steps involved in the over-all reaction must balance energywise. If the Langmuir-Hinshelwood mechanism is to apply, only those chemisorbed species having the right free energies of adsorption will take part in the reaction. This may not apply to some reactions having high energies of adsorption especially at lower temperatures, and it is for this reason that the alternative reaction mechanism discussed has been proposed.

Decision between these two proposals for hydrogen-deuterium exchange and ethylene hydrogenation over metals has not yet been decided although new evidence favors the Langmuir-Hinshelwood mechanism.[54 55]

Conclusions

After reviewing the present status of the scientific knowledge of the field of heterogeneous catalysis, it is most obvious that the science of catalysis is really only at a good starting point.

The ultimate goal of research in this field is the prediction of the optimum catalyst from the standpoint of activity, selectivity, and stability for a given reaction. Achievement of this goal will be a tremendous task, but it will come in time. The more immediate problems confronting fundamental catalytic research are pointed out in the test. In summary, the basic needs are much greater detailed knowledge of the following:

1. The physics and chemistry of surfaces of solids.
2. The nature of chemisorption and its relation to catalysis.
3. Mechanism of catalytic reactions.
4. Kinetics of catalytic reactions.
5. Thermodynamics of adsorption-desorption of reactants and products.

Specifically, the nature of catalyst surfaces needs to be explored further to determine the conditions existing there, such as mobility and the exact nature of the chemical bonding properties of surfaces. Are the electronic properties as predicted from bulk properties correct for surfaces? How are adsorbed substances bound to the surface? And, are the adsorbed species anchored or are they free to move? What kinds of interactions exist between adsorbed species? How does a catalyst activate the chemisorbed species? What structural properties differentiate an active center from the re-

mainder of the surface? These are but a few of the large number of questions remaining to be answered concerning catalytic reactions.

Other questions . . . How will these questions be answered and how will a better understanding of the interrelated factors in catalysis be accomplished? The fact that such mountainous problems remain in this field is mute evidence that our efforts are not sufficient and that our concepts and techniques of experimentation are far from adequate. Present techniques need to be refined in order to obtain more definitive data. A more critical interpretation of the data is also required. Kinetic and thermodynamic data of proper definition can shed much light on the nature of the chemisorbed and the activated species involved in catalytic reactions.

In developing new techniques and new concepts in catalysis, catalytic chemists should look to other fields of chemistry. The carbonium ion mechanism was developed in the field of organic chemistry. What can we learn from still other fields, particularly other fields of surface chemistry, such as corrosion, electrochemistry, ion exchange, etc.?

We need to design experimental methods which will yield direct information about the important factors in catalysis. Most of the existing procedures yield indirect information, and the conclusions are therefore obtained by inference. The recently introduced technique of studying chemisorption by means of infrared adsorption[58] is an excellent example of a method yielding direct information on an important catalytic factor.

Research needed . . . Greater emphasis on fundamental catalytic research in our industrial and university laboratories is a most important goal if the United States is to maintain its lead in the industrial application of catalysis. The stakes are high in this field. For instance, considerably less-expensive methods for fixing nitrogen would achieve much in alleviating the world's ills. Such a goal is not an impossibility. After all, nature fixes atmospheric nitrogen at atmospheric temperature and pressure.

Getting more valuable products out of every barrel of crude oil is the objective of the petroleum industry. Catalysis will play an increasingly important role in achieving this goal.

"In developing new techniques and new concepts in catalysis, catalytic chemists should look to other fields of chemistry . . . The recently introduced technique of studying chemisorption by means of infrared adsorption is an excellent example of a method yielding direct information on an important catalytic factor."

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"Greater emphasis on fundamental catalytic research in our industrial and university laboratories is a most important goal if the United States is to maintain its lead in the industrial application of catalysts."

SLIDE VALVE became disengaged due to coke deposits and high-temperature. Fig. 1.

INSPECTION OF CO BOILER showed some slight cata'yst buildup on the burner ports. Fig. 2.

REPORT: SINCLAIR'S HOUSTON REFINERY FLUID UNIT

359 Days' Uninterrupted Operation

Unit shows ample ability to exceed design conditions

by Robert M. Cooper and Alex E. Shaw

ON November 11, 1953, the Houston refinery fluid unit was brought on stream for its initial run. On November 6, 1954, the unit was brought down on schedule for the first turnaround. Between these two dates were 359 days of uninterrupted operation; not even a reactor bypass disturbed the continuity of operation. Here is a brief story of what the unit did during the year of operation, the turnaround and condition of the unit, and what is planned for the future as a result of operation and inspection.

What the unit did . . . A previous article set forth design operating conditions. Table 1 compares design charge and products with the average yields obtained during the entire period of operation. It has been possible to operate the unit at higher than anticipated conversion levels and yet secure excellent liquid recovery and product distribution even when processing heavy feed stocks at conversion levels in the 73-75 per cent range.

This is partially the result of less than design charge to the unit but is also a result of low carbon on regenerated catalyst. The thorough stripping of hydrocarbon from the spent catalyst in the reactor stripping well and the excellent distribution and contact of spent catalyst and regeneration air above the regenerator grid combine to produce a regenerated catalyst with a maximum of 0.2 per cent carbon.

The Turnaround

In May 1954 the fluid unit turnaround was scheduled to take place in November.

The speed with which any unit can be turned around depends on the overall planning and cooperation of all departments in the plant. This planning must start many months in advance of the turnaround, and in fact actually starts when the unit is brought on stream.

From the beginning of operations the operating, mechanical, and inspection departments start to compile their lists of repairs and revisions, desirable or required, to the unit with its many

TABLE 1—DESIGN VS. ACTUAL FEED AND PRODUCTS

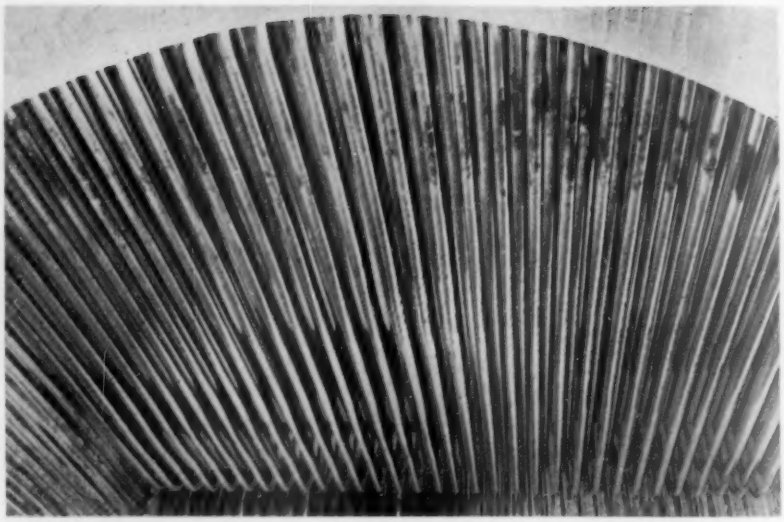
	Design		Actual	
Feed	Bbl./day	Per cent	Bbl./day	Per cent
Virgin gas oil	40,000	100.0	32,487	103.0
Recycle	9,700	24.2	15,313	47.1
Total reactor feed	47,700	124.2	48,800	147.1
Products				
Propane-propylenes	2,200	5.5	1,951	6.0
Butane-butylenes	4,000	10.0	4,618	14.2
Light fluid gasoline	18,000	45.0	14,262	43.9
Heavy fluid gasoline	1,960	4.9	3,216	9.9
Total C_5+ gasoline	19,960	49.9	17,478	53.8
Light cycle oil	6,400	16.0	6,432	19.8
Heavy cycle oil	6,400	16.0	292	0.9
Clarified oil	1,200	3.0	1,689	5.2
Total C_4+ liquid recovery, per cent	94.9		93.9	
Conversion (C_4 —400° e.p.), per cent	65.0		72.1	

hundred pieces of equipment. These lists are correlated by the operating department which has the responsibility for seeing that all items are included that are necessary for the safe and efficient operation of the unit.

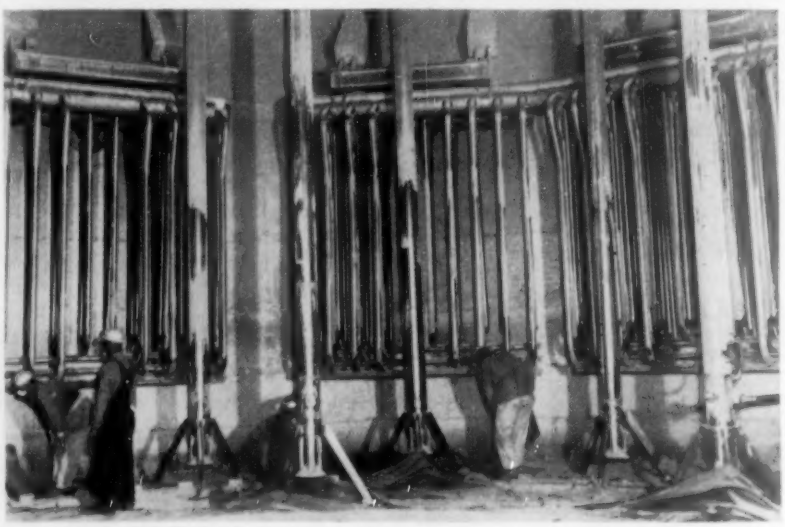
The first "Repair Sheet" for the fluid unit turnaround was issued June 1, some 5 months before the scheduled turnaround date. The repair sheet was divided into two sections, "Shutdown" and "Preshutdown." Each division was further broken down into areas and then into categories as vessels, machinery, and heat exchange equipment. The preshutdown repair sheet included actual cleaning and repair work that might be done prior to the shutdown and also included those items requiring engineering, purchasing, or fabrication. These latter items were referred to the engineering department where the necessary drawings were prepared and requisitions placed with purchasing. As drawings were completed prints were issued to the crafts involved for fabrication.

First meeting . . . Four months prior to the shutdown the first turnaround meeting was held. This was an orientation meeting at which representatives of refinery, management, operation, engineering, maintenance, inspection, and safety went over the scope of the work and discussed the major jobs involved. Here was begun the cooperative thinking and planning required for an efficient and orderly turnaround of the fluid unit; tentative time schedules, tools, special equipment, lunch periods, temporary offices and tool rooms, material handling, and many other essential items were discussed.

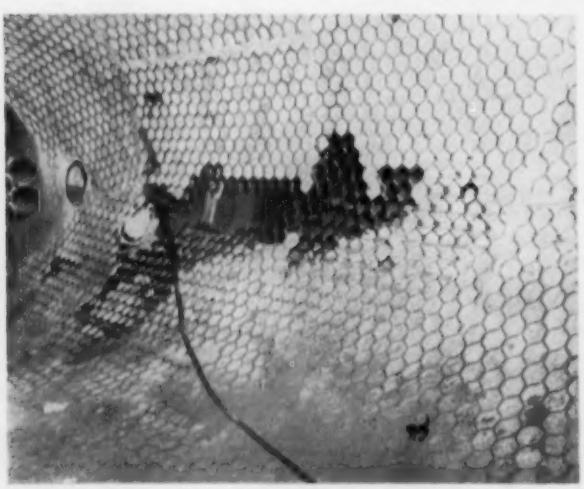
These turnaround meetings were held with increasing frequency until one per week was scheduled for the month prior to the shutdown. By this time questions



BOILER AND ECONOMIZER tubes on the CO boiler picked up some catalyst deposit. Fig. 3.



CATALYST REGENERATOR was in excellent condition. There was no indication of excessive wear or distortion. Fig. 4.



REFRACTORY LINING in the reboiler riser required some patching. Fig. 5.

TWO GRID AREAS in the reactor proper were replaced because of erosion. Fig. 6.

SEVERAL BAFFLES on the bottom section of the fractionator were out of position. Fig. 7.

of policy and procedure had been answered and the repair sheet had undergone numerous revisions, items had been added and deleted until the final edition represented the best estimate of the work actually required. The preshutdown repair sheet now carried the drawing numbers of engineered items and had been expanded to the point where substantially all work was being done that it was possible to do, even though manhours required for the job might be more than if done during the shutdown.

This preshutdown work included:

1. Cleaning as much heat exchange equipment as possible.
2. Installing fabricated piping up to tie-in-points.
3. Installing foundations and setting an auxiliary air blower and two pumps and turbines.
4. Checking and repairing instruments and control valves.
5. Installing chemical cleaning vats and piping.
6. General preparatory work for jobs to be done during the shutdown.

It was known beforehand that the following major items would be done:

1. Install a 2-in.-thick multiple hole orifice in the 96-in.-diameter regenerator flue gas line to the CO boiler.
2. Replace an eroded 96-in.-diameter mitered ell with a 13-ft.-diameter expansion pot.
3. Replace one 50-in. and two 36-in. hydraulic slide valves. Fig. 1 shows a 36-in. slide valve where coke deposits and excessive temperature allowed the stem to become disengaged and render the slide valve inoperable. This represents the only equipment failure to cause any operating difficulty during the year run.
4. Replace seals on two 5,100-hp. centrifugal gas compressors with a new type. This required opening the case and removing the rotor for machine work.
5. Make permanent tie-in of second CO boiler stack. The single stack and breeching provided in the original installation imposed sufficient back pressure on the CO boiler furnace to require bypassing a portion of the regenerator flue gas direct to the stack. A second stack was installed and temporary connections were made during operations to relieve gas-furnace pressure and allow the full quantity of regenerator flue gas to be burned in the CO boiler.

Assigned areas . . . To facilitate an orderly movement of material to and from the various mechanical crafts, each craft was assigned a marked-off and labeled area around the unit boundary for any portable tool boxes, temporary craft office, and equipment and material deliveries that it might have. A temporary office for mechanical department headquarters and a temporary storeroom were moved into the unit area. Because of the size of the fluid unit a communication problem existed. To reduce delays in relaying orders or locating personnel a public-address system was installed along with additional temporary unit intercom phones and refinery telephones.

Further preparation included erection of scaffolds where possible and placing scaffold material in accessible areas near vessel manways where it was known that scaffolding would be required. Utility stations were checked and additional air and water hose made ready. Numerous strings of temporary lights were readied and located in areas where they would be required.

Welding machines and leads were made available in areas where the work would be concentrated. Hoisting equipment was installed where it would be required if it was possible to do so without interfering with operations. Preparedness was emphasized, "leave nothing for the shutdown that can be done beforehand."

Direction . . . The active direction of the turnaround work was the responsibility of three still-maintenance foremen, each of whom had a given area, through the craft foremen and their assistants. All are responsible to the plant master mechanic or his assistant who directs the over all turnaround efforts. Daily meetings, lasting possibly 30 minutes, were held under the direction of the master mechanic.

Representatives of each craft as well as refinery management, engineering, operations, inspection, and safety attended. These meetings served as a clearinghouse for information on each craft's progress on the job, news of additional work uncovered by inspection or operations, and provided a place to coordinate the thinking of everyone involved in the turnaround.

A general policy on all turnarounds is to open, clean, and inspect as soon as possible in order better to know the full extent of repair work required.

R. M. COOPER

THE AUTHORS

Robert M. Cooper is head of the light-oil division of the Houston refinery of Sinclair Refining Co. He received a B.S. degree in chemical engineering from Rice Institute. After service in the Houston refinery's technical, cargo and terminal, and alkylation departments, he was moved to Sinclair's Corpus Christi refinery during World War II to head the 100-octane-production facilities there. In 1951 he was transferred to serve as a project engineer in the construction by C. F. Braun & Co. and Fluor Corp. of new facilities in the refinery-expansion program. He was advanced to his present post on March 1, 1953.

Alex E. Shaw, assistant master mechanic, Houston refinery, of Sinclair Refining Co., was graduated from Georgia Tech in 1941 with a B.S. degree in general engineering. After 6 years as a project engineer with the Air Material Command of the Army Air Forces, he joined Sinclair in 1947 as a construction engineer. Since joining Sinclair he has been associated with both construction projects and the maintenance department.

A. E. SHAW

MANPOWER REQUIREMENTS for the duration of the shutdown. Fig. 8.

TABLE 2—MAN-HOUR REQUIREMENTS BY CRAFTS

	Preshutdown	Shutdown	Total
Boilermakers	4,155	7,862	12,017
Brickmasons	73	1,831	1,904
Carpenters	1,522	2,383	3,905
Cranes		48	48
Electricians	1,043	1,398	2,441
Instrument men	839	2,411	3,250
Insulators	272	2,331	2,603
Labor	2,383	8,104	10,487
Machinists	1,207	4,932	6,139
Painters	632	1,472	2,104
Pipefitters	4,355	10,124	14,479
Riggers	1,798	3,742	5,540
Special equipment	290	655	945
Tinners	199	434	633
Trucks	225	826	1,051
Welders	2,953	5,076	8,029
Total	21,946	53,629	75,575

This policy was carried out on the fluid unit and, by maintaining close contact with operations, the work of opening vessels and other equipment was begun as soon as they were gas free. In order to expedite the inspection of the main fractionator, deethanizing absorber, and depropanizer, these systems were chemically cleaned simultaneously using three separate chemical circulation systems.

As a result these towers were clean and gas free in less than 48 hours after the reactor was bypassed. On other equipment, cleaning forces followed closely behind workmen opening the vessels and it was possible to get an early inspection on much of the equipment. This did not hold true on the reactor and regenerator as catalyst removal and cleanup was slower than expected resulting in some delay in making the inspection.

Condition of unit . . . Inspection showed the unit, in general, to be in good shape. The CO boiler was shut down later, and brought up earlier, than the fluid unit proper in order to provide the necessary steam and prevent a drag on the refinery system. There was some slight catalyst buildup at the burner ports (Fig. 2) and there was some catalyst deposit on the boiler and economizer tubes (Fig. 3). Only washing and minor repairs were required in this area.

The regenerator was in good condition, the grid intact, lining in excellent condition, cyclones, dip legs, and re-spray superheater coils all showed no indication of excessive wear or distortion (Fig. 4). In the regenerator riser portions of the refractor lining required patching (Fig. 5). Pictured is a worn section after being cleaned out ready for patching.

Additional refractory patching was required in the reactor riser where refractory and reinforcement wear took place near the oil inlet and in the short radius ell section of the riser. In the reactor proper two grid areas (Fig. 6) were replaced because of erosion caused by failure of the deflector plates over the risers. These deflectors had broken loose and allowed the blast from the risers to be concentrated on a small area of the grid. The deflectors were reinstalled with additional supports.

An unexpected job of some magnitude developed in the fractionator when several of the baffles in the bottom section were found to be out of position (Fig. 7). It was necessary to straighten the baffles and provide additional supports and stiffeners to decrease the possibility of reoccurrence.

Man-hours . . . A preshutdown estimate of manpower required during the shutdown period indicated 48,352 man-hours which is in close agreement with the actual figure of 53,629 as shown in Table 2. Considering the available manpower and the goal of 16 day's down time, it was believed the best method of manning the job was to work the regular 8-hour day shift plus 6½ hours overtime with the critical crafts.

In addition, it was evident that certain jobs would have to be manned around the clock so the necessary craftsmen were put on shift to cover these critical jobs. Since it is necessary to provide meals for personnel working overtime, arrangements were worked out whereby the men were transported at 10-minute intervals between 5:30 and 6:00 p.m. to the refinery cafeteria for a hot meal.

Table 2 gives the breakdown of man-hours required from each craft. As on major turnarounds of other units the pipe fitters, boilermakers, labor, and welders contribute the majority of the man-hours. Fig. 8 shows man-hours worked daily during the shutdown period. On Sunday, November 14, shorter hours were worked to provide a rest break, otherwise substantially maximum man-hours were put in until areas began to finish on the eleventh day of the shutdown. From this time on manpower requirements fell rapidly as equipment was tested and made ready for operation.

Planning and manning the turnaround was successful, final pressure testing of equipment was in progress the evening of the thirteenth day, and the unit was brought on stream just 14 days 8 hours after bypassing the reactor.

Future Plans

The experience gained in this, the first Houston fluid unit turnaround, will improve the accuracy of the planning and scheduling of future turnarounds. The installation of some additional nozzles for catalyst removal made on this turnaround in conjunction with increased ejector capacity will speed inspection and repairs in the reactor-regenerator section on the next turnaround.

In operations, experience during the past year has shown excellent results are obtained by running the unit at high conversions. During the first year of operation it was necessary to sacrifice propane-propylene recovery, since the wet gas make exceeded centrifugal compressor capacity. This dictated a lower absorber pressure. There is now on order a centrifugal gas compressor and auxiliary equipment to be installed as a second-stage booster. This will enable the fluid unit gas recovery-absorber unit to operate at pressures to 175 psi. with consequent high C_3 recovery. Connections for this equipment were made during the turnaround so that installation can be made during operations.

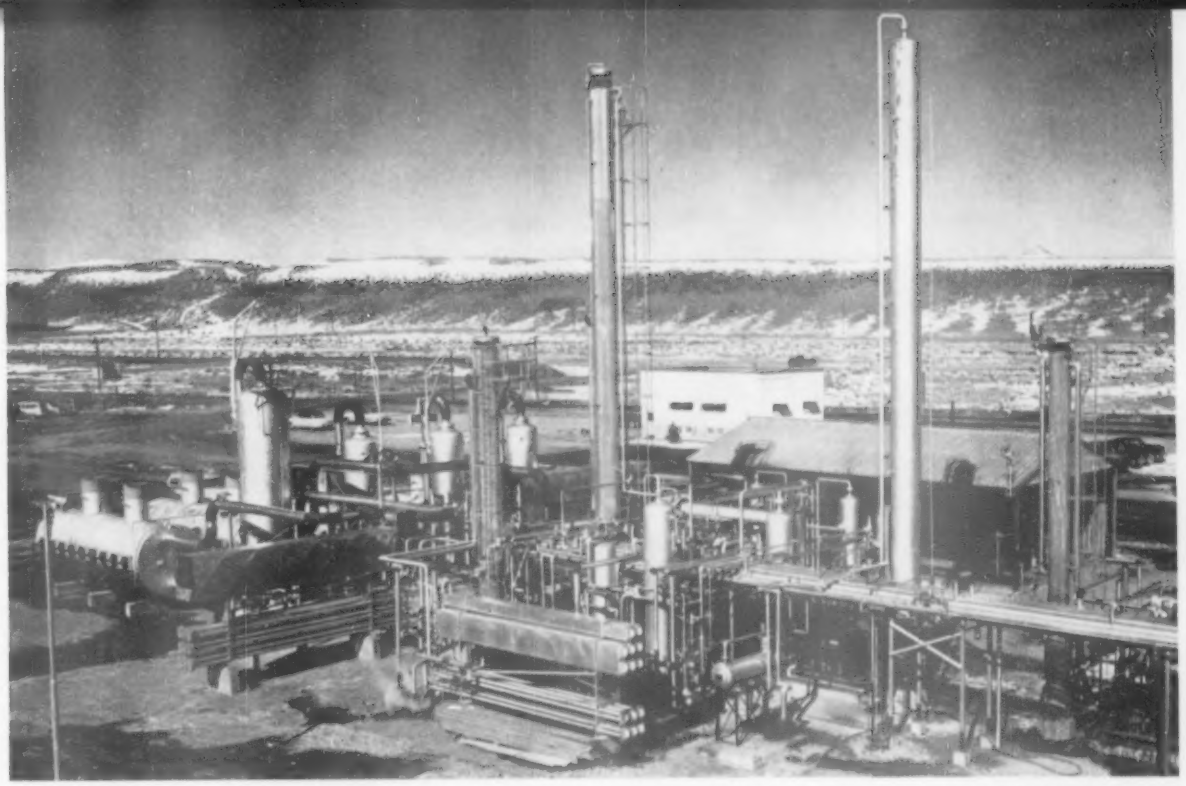
During the past turnaround, connections were made to tie in D.E.A. scrubbers to remove H_2S from the fluid unit dry gas and liquid propane-propylene streams.

Conclusion

The fluid unit and CO boiler, in the first year of operation, have demonstrated ample ability to meet and exceed the design conditions. In addition the physical layout of equipment and the provisions built into the unit to promote ease of maintenance demonstrated their worth in the turnaround just completed.

Reference

1. Latest Design Features Incorporated in Sinclair's New 40,000-bbl. F.C.C. Unit, by F. Lawrence Resen, The Oil and Gas Journal, Vol. 52, No. 40, page 80 (February 8, 1954).



CHARGE HEATER and reactor for the Cody Diesulformer are at extreme left. In the background are the three smaller Catformer reactors. Between two of these is the Diesulformer stripper. Heaters, accumulators, and exchangers are on the same skid as the stripper.

DIESULFORMING . . .

Husky Oil Co.'s Desulfurization Process

by F. B. Odasz and J. V. Sheffield

Why Husky Developed Diesulforming

THE marketing of high-sulfur distillates is one of the problems faced by refiners of heavy crude oils in the Rocky Mountain area. Petroleum refiners have long sought an economical method of upgrading the increasing amounts of high-sulfur distillate stocks that are being run today. A number of processes have been developed, but very few are economically feasible.

Husky Oil Co., of Cody, Wyo., needed a process to upgrade the kerosine and diesel fractions obtained from high-sulfur Oregon basin crude. A little over 2 years of research resulted in Diesulforming—a flexible desulfurization process which transforms a high-sulfur charge to a sweet desulfurized diesel fuel possessing excellent color, odor, and burning characteristics. The Husky Diesulformer at Cody was the first diesel desulfurizing unit in the United States.

Development . . . When postwar catalytic reforming developments indicated that the small refiner could economically produce high-octane gasoline by catalytic reforming, the opportunity of utilizing the byproduct hydrogen from reforming to desulfurize high-sulfur distillates induced Husky to support laboratory work at Montana State College under the direction of Dr. Lloyd Berg. These studies, started in December 1950, were based upon improvements in the early German hydrogenation research efforts performed with molybdenum and other metallic oxides during the late 1920's and early 1930's.

Success in the college's 0.01-bbl. per bay laboratory equipment facilitated pilot-plant investigations by Husky at its laboratories in Cody in November 1952 in a 2-bbl. per day unit. This unit confirmed the data for the design and construction of the 1,000-bbl. per day commercial unit.

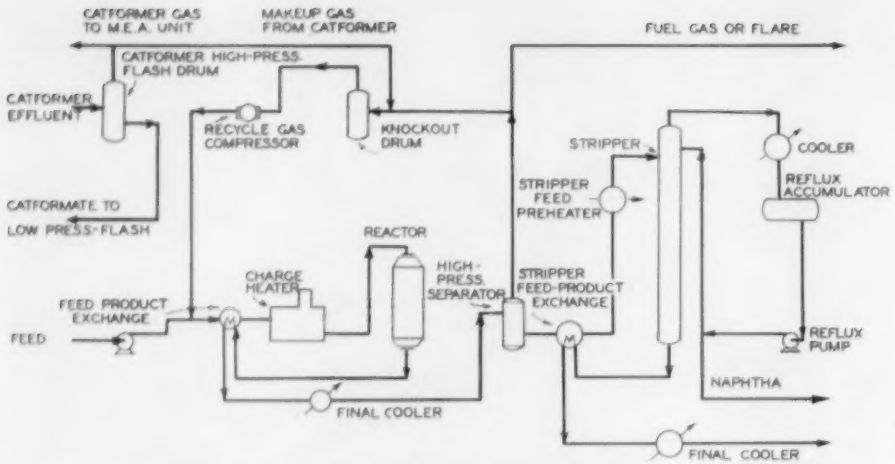
WHEN Husky Oil Co. decided to install a 1,000-bbl. per day Atlantic Catformer at Cody, Wyo., the company contracted for the simultaneous installation of a Diesulforming unit to be integrated with it.

Both units were constructed by Grebe & Doremus Process Co., of Houston, who assembled much of the piping, pumps, and other small equipment at Houston on skids which were later transported to Cody and placed in a preplanned position.

Unit design . . . As shown in the flow chart, Fig. 1, the Diesulformer is simple in design and closely integrated with the Catformer operation. One man is able to operate both units and still have time to weigh about 20 tank trucks per shift.

Distillate feed stock and hydrogen are first preheated by exchange with reactor effluent. The combined feed is

Authors are with Husky Oil Co., Cody, Wyo.



SCHEMATIC FLOW DIAGRAM for the Husky Diesulformer.

then heated further in a small furnace to 650°-700° F. The charge then passes down through a fixed-bed catalyst chamber which is similar in design to the Catformer reactors. After heat exchange with the charge stock, the product is separated from the hydrogen-rich gas in a flash drum. A gas-engine-driven compressor recycles the gas back to the incoming feed.

The liquid effluent from the flash drum is stripped of hydrogen sulfide and any low-flash constituents. This sweet, desulfurized diesel fuel is then stored for marketing. No further treatment is necessary.

The small amount of H_2S saturated naphtha recovered from the stripper overhead is rerun through the refinery crude fractionator.

Process . . . The primary purpose of the Diesulformer is to reduce the sulfur content of the charge stock. However, the process also removes nitrogen and oxygen, and provides the additional advantages of color, odor, and cetane improvement.

Most of the research on the process has been on Oregon basin stocks, but other types of feed stocks are now being investigated to determine the commercial versatility of the process. The optimum economic conditions of operation depend mainly upon the characteristics of the charge stock.

Catalyst activity has been remarkably good; the original ⅛-in.-diameter pellets are still as active as when the reactor was first charged. The unit has required no shutdowns for regeneration since the plant began operation in August 1953, 19 months ago. However, provisions to regenerate the catalyst in place with the mixture of steam and air at 1,000° F. have been included in the design.

Since the catalyst is extremely stable at these temperatures repeated regenerations are possible. Therefore, the catalyst is expected to last indefinitely under normal operating conditions. Most of the Cody operation has been on the 34° A.P.I. stock, reducing its sulfur content from 1.8 to 0.3 per cent. Table 1 lists typical inspections of the charge stock and products for the Cody unit.

TABLE 1—INSPECTIONS ON CHARGES AND PRODUCTS

	Light diesel		Heavy diesel		No. 2 burner fuel		No. 1 burner fuel	
	Charge	Product	Charge	Product	Charge	Product	Charge	Product
°A.P.I.	35.9	37.9	32.3	35.0	30.2	33.2	39.2	40.6
Per cent sulfur	1.32	0.21	1.77	0.37	2.2	0.35	1.02	0.105
Initial	361	371	392	362	473	415	379	363
10 per cent	422	424	464	451	516	512	408	393
50 per cent	491	493	554	552	570	564	440	432
90 per cent	601	597	619	611	624	617	495	488
End point	666	663	674	664	656	658	533	545
Flash	155	160	165	160	230	202	154	147
Aniline point, °F.	142	148	145	153	142	152	136	143
Pour	—20	—20	0	0	5	5	—50	—50
Product yield, vol. per cent		97.3		98.6		98.4		96.2
Naphtha yield, vol. per cent		2.7		1.5		1.7		4.0
Per cent S removal		84		79		84		90
H_2 consumption, s.c.f. per bbl.		115		138		150		93
Odor	Poor	Good	Poor	Good	Poor	Good	Poor	Good
Doctor							DNP	Pass
Cetane	47	50	48	51	48	52	45	47

Temperature and space velocity are the important variables. Desulfurization is directly proportional to the temperature and inversely proportional to the space velocity. Secondary variables such as pressure, purity of the hydrogen, and recycle rate are interrelated. In general, the most efficient desulfurization is obtained when the partial pressure of hydrogen in the reactor is high.

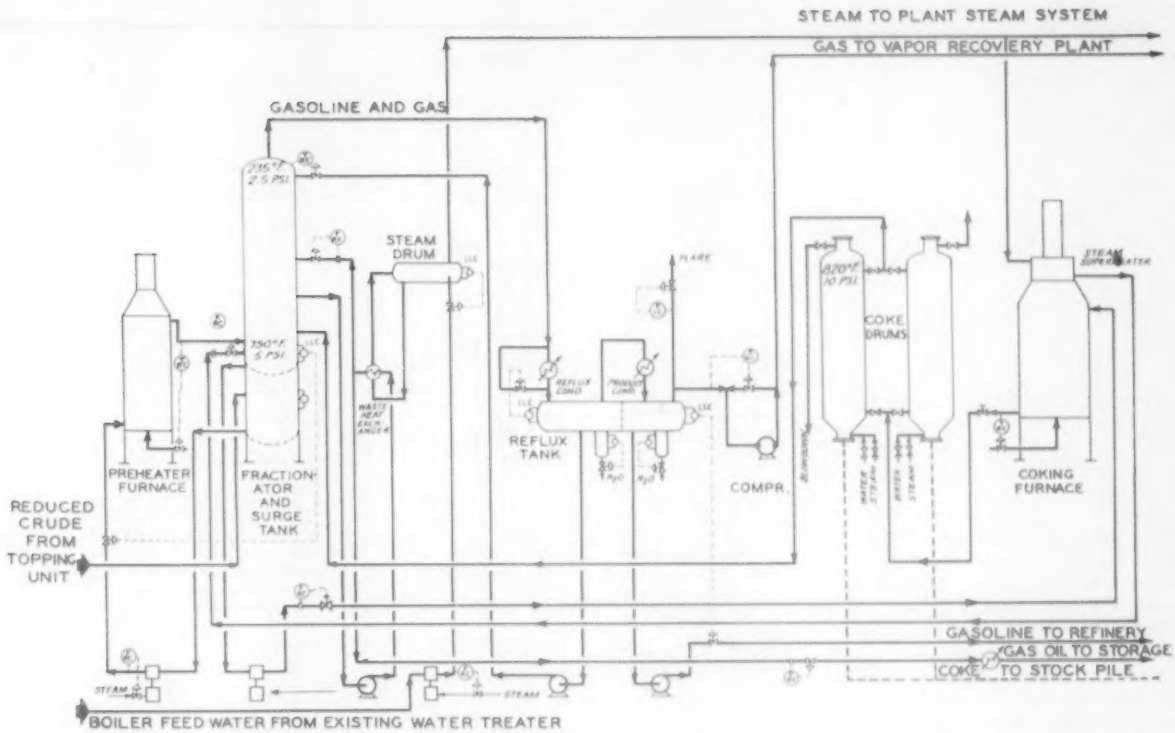
Recycling the hydrogen-rich gas decreases the resistance of the absorbed film on the surface of the catalyst and increases the rate of diffusion of reactants and products from the catalyst surface. Hence, under recycling conditions lower pressures and higher space velocities are more feasible than when no recycling is used. However, economics should be the governing factor in deciding design for a particular charge.

First in Canada . . . A second 1,000-bbl. per day Diesulformer is being built for Husky Oil & Refining, Ltd., by Fluor of Canada at the recently acquired Moose Jaw refinery. This unit will be the first of its kind in Canada. Distillates from Fosterton, Success, and Cantuar crudes will be desulfurized with hydrogen from a 1,000-bbl. per day Atlantic Catformer. The Canadian unit will have no major design changes from the highly successful unit operating in the Cody refinery.

Diesulforming process is available for licensing through the Husky Oil Co. of Cody, Wyo.

Acknowledgment

The authors gratefully acknowledge the efforts of Don Nafus, John Hartwig, and R. V. Witter for operating the pilot plant and for analysis of the products, and to the Husky Oil Co. for permission to publish this paper.

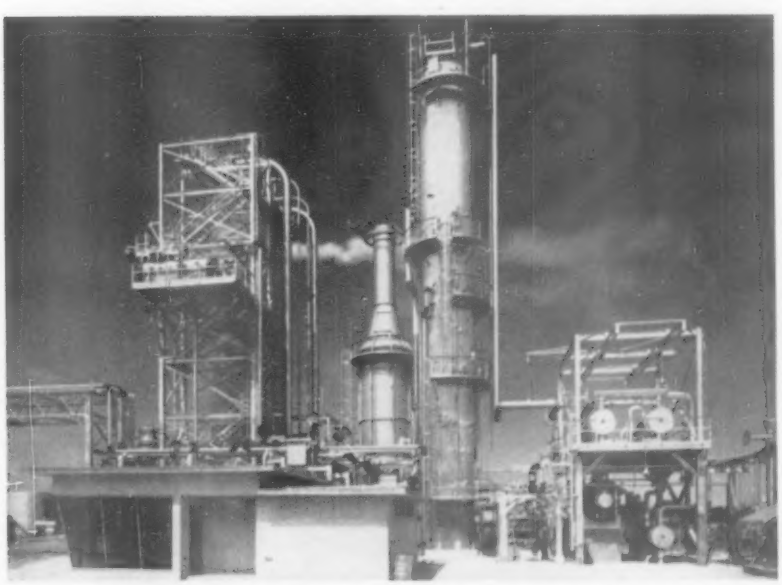


NEW DECARBONIZING UNIT at McMurrey Refining Co., Tyler, Tex., is operated at low pressure to obtain large yield of gas oil in the coking drum. Fig. 1.

Gasoline production rises to 69 per cent

Decarbonizing Process Improves Flexibility

by Gerald L. Farrar
Engineering Editor



DEEP FLASH of virgin stock is obtained by heating reduced crude feed going to fractionator in an oversized preheater.

THE decarbonizing unit at McMurrey Refining Co., Tyler, Tex., provides for maximum recovery of high-value, salable products from reduced crude. Bottoms from the atmospheric topping units are processed to produce maximum coker distillate for catalytic cracking, and minimum coke and coker gasoline.

This upgrading of residuum to maximum high-quality gasoline is possible because of these factors:

- The unit is operated at low pressures. Low pressure favors efficient separation in the fractionator and large yield of gas oil in the coking drum.
- Reduced crude feed to the fractionator is heated in an oversized preheater and a deep flash of virgin stock results. This eliminates the need for a vacuum unit, assures maximum yield of virgin gas oil, and reduces net charge to the coking section.

Total refinery gasoline production has risen to 69 volume per cent since the decarbonizing unit was installed.

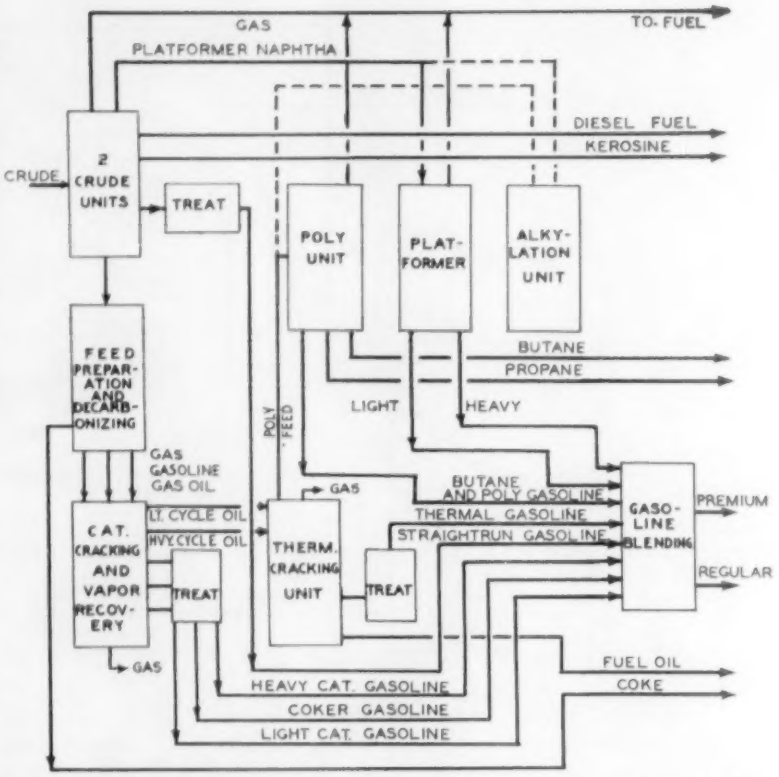
Economical operation . . . The unit is economical. McMurrey operating costs, including direct charges, taxes and insurance, administration and overhead, and 15-year amortization are approximately $0.12 per barrel of reduced crude charged. The unit is self-sufficient in net steam consumption.

The process is very simple to operate. The unit was started up efficiently and uneventfully by a regular crew of operators without previous instruction in decarbonizer operation.

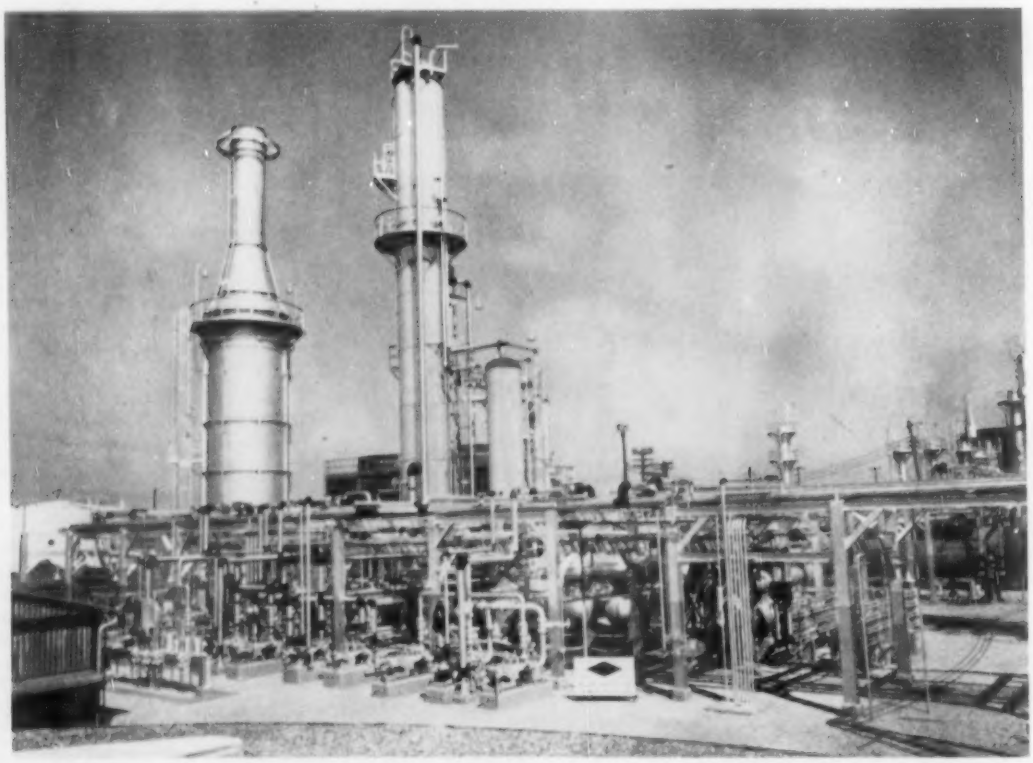
The decarbonizing process is a development of the Chemical Plants Division, Blaw-Knox Co. The McMurrey unit is the first to be put into commercial operation. The unit went on stream in early June 1954, and the maiden run lasted until December 30. Operation throughout the run was at design specifications.

What it is . . . The decarbonizing process is basically a feed-preparation system for catalytic cracking, running to coke. It consists of a preheater, a fractionator, a coking furnace, and two coke drums (see Fig. 1).

Secret of the high gas-oil yield and low yield of coker gasoline and coke in the McMurrey operation is the use of low pressure throughout the system. Pressure on the bottom tray of the fractionator is 5 psi., and that on the top tray is 2.5 psi. Low pressure in this column allows more complete separa-



PROCESS SCHEME at McMurrey's Tyler refinery. Installation of the decarbonizing unit has resulted in increased refinery gasoline production. Fig. 2.



NEW CRUDE UNIT, installed in 1954. Combined capacity of this and the older crude unit is 25,000 bbl. per day.

tion of gas oil and lighter from the heavier components in the reduced crude.

Of the 8,300-bbl. per day charge, about 2,100 bbl. of bottoms from the fractionator are sent to the coking furnace. The difference is removed as gas oil.

Coking is carried out in the coke drums at 820° F. and 10 psi. These conditions provide for maximum gas oil formation and minimum coke and coker gasoline.

Operating results . . . Representative operating data for the first 6-month operating period check design figures very closely. This is shown in Table 1.

TABLE 1 — OPERATING RESULTS — McMURREY DECARBONIZING UNIT

	Actual	Design
Charge:		
Reduced East Texas crude, bbl. per day	8,300	8,000
Reduced-crude inspections:		
Gravity, °A.P.I.	26.0	26.0
Carbon residue	3.75	3.98
Yields:		
Wet gas, M.s.c.f. D.	825	660
Coker gasoline, volume per cent on charge	5.6	5.63
Gas oil, volume per cent on charge	90.6	90.6
Coke, tons per day	67	64

Process flow . . . Reduced crude from McMurrey's two topping units flows to a surge drum in the base of the fractionator and then to the preheater furnace. Flow rate is controlled by a liquid-level controller on the bottom of the fractionator. Temperature of the preheater effluent is maintained by a temperature controller operating a valve in the fuel-gas line.

Hot reduced crude from the preheater is flashed into the fractionator. Additional flashing is brought about by hot stripping steam and the heat supplied by the coke drum effluent. Maximum vaporization of fresh feed is thus attained, and charge to the coke drums is kept to a minimum.

The fractionator bottoms stream is pumped through a vertical coking furnace to the operating coke drum. Flow is maintained constant by a recording flow controller. Another instrument regulates the amount of steam entering the coking-furnace coil. Steam to be used in the furnace and fractionator is superheated in a separate coil in the furnace.

The coking furnace effluent is flashed into the coke drum. Vapor leaves at the top of the drum, and liquid remains to be converted to coke. Coking is carried out in this vessel at 820° F. and 10 psi. As coke is formed more vapor is released, taken overhead, combined with the vapor formed on the initial flash, and returned to the fractionator.

Vapors from the coke drum flow to the base of the fractionator. In the column total gas oil is condensed and withdrawn from a well-type tray. Gas-oil product plus intermediate reflux is pumped through a waste-heat exchanger which generates process and utility steam. Enough steam is produced to make the process self-sufficient in net steam consumed.

After passing through the waste-heat exchanger, the gas-oil stream is split into two parts. Intermediate reflux is maintained at a constant rate by a flow controller. The remainder of the gas-oil stream is sent to storage as net product.

Light products . . . Stripping steam, gas, and gasoline are taken overhead from the column and passed through the reflux condenser. A level control on the reflux tank operates a bypass around this condenser, so that net product enters the reflux drum as a vapor. This vapor then passes through the product condenser and into the product side of the reflux tank. Rate of reflux to the fractionator is adjusted by a controller which controls temperature on the top tray.

Gas is taken from the product drum, compressed, and sent to a vapor-recovery plant. Compressor suction pressure is controlled by a throttling valve in the bypass line.

Liquid product from the product drum is net coker gasoline. Flow of this material to the gasoline-blending units is adjusted by a level controller on the drum. The controller actuates a valve in the gasoline effluent line.

Coking operation . . . Two coking drums are used in the McMurrey installation, with one drum in coking operation while the other is being decoked. The drums are sized for 48-hour cycles, with each drum in coking service 24 hours. Only one decoking crew is required each day.

Simple mechanical equipment is used for coke removal. The actual decoking is done in less than 2 hours, and the whole operation of unheading, decoking, and heading up is finished in 6 hours.

The coke drum taken off stream is steam stripped. Water is admitted to the bottom of the drum, and the steam formed is vented to the blowdown stack. When the drum has cooled sufficiently water is drained and the decoking crew unleads the coke drum and positions the drilling engine. Drilled-out coke funnels out of the bottom of the drum on to a conveyor which carries the material directly to railroad cars.

After coke removal, the drum is headed up and preheated with hot oil vapors before being placed on stream.

Refinery Process Scheme

A block flow diagram of the refinery processing scheme is shown in Fig. 2. There are two atmospheric topping units, one completed during the early part of World War II, and one designed and built by Blaw-Knox in 1954. The older unit was modernized in 1947. Combined capacity of the two units is some 25,000 bbl. per day. During normal operation, the units handle a total of 15,000 bbl. per day .

Gas, Platformer naphtha, diesel fuel, kerosine, and reduced crude are taken off in the crude units. Reduced crude is sent to the feed-preparation and decarbonizing units. Gas, gasoline, and gas oil from these units are fed to the vapor-recovery and cat-cracking units.

Light cat gasoline, heavy cat gasoline, and coker gasoline are pumped from the cat cracker and vapor-recovery units to gasoline-blending operations. Light and heavy cat cycle oil streams are sent to a two-coil thermal cracking unit for conversion to poly-unit feed, thermal gasoline, and fuel oil.

The cat cracker has been down only twice in 4 years. It started operation May 11, 1951. First shutdown was March 15, 1953. The second shutdown was January 27, 1955. Rated capacity was 5,500 bbl. per day until the second shutdown. At that time, capacity was increased to 7,200 bbl. per day by modifications to the air blower and elimination of other bottlenecks.

The thermal cracking unit, which was originally a visbreaking unit, was converted to thermal cracking when the decarbonizing unit was installed.

Gas from the thermal cracking unit is sent to the poly unit which was installed in 1947. Polymer gasoline and butane from this unit are pumped to gasoline blending facilities. Butane, propane, and dry-gas streams are also recovered.

A sulfuric acid alkylation unit and aviation-gasoline facilities are now under construction. When this project is completed this summer, the poly unit will be shut down, and all refinery butylenes and propylene will be alkylated. Capacity of the alkylation unit will be some 2,500 bbl. per day of aviation gasoline.

A 180°-400° F. straightrun naphtha is recovered from the topping units for Platformer feed. Light and heavy reformed naphthas are produced in the Platformer and sent to gasoline blending operations.

Other construction . . . In addition to the process improvements, the refinery electrical distribution system has recently been completely overhauled, and a large amount of other work has been done. Blaw-Knox has been the contractor for these projects.

Journal Survey of Refineries in the United States

THEIR DISTRIBUTION AND CAPACITIES

(Capacity, barrels per stream day)

	No. plants	Crude oil	Vacuum dist.	Thermal operations	Catalytic cracking	Catalytic reforming	Hydro-genation	Alky.	Poly.	Lubes	Coke (tons)	Asphalt
Alabama	4	14,450	8,700									11,000
Arkansas	6	73,000	28,800	13,500	34,600			2,650	850	3,200	400	7,600
California	42	1,315,500	353,990	543,260	363,300	68,900	22,500	43,984	4,075	21,210	1,100	45,157
Colorado	7	38,750	8,700	9,750	7,700				750			2,000
Delaware	1	3,500	1,750									1,500
Georgia	1	6,500										3,000
Illinois	13	522,900	127,200	162,875	221,250	36,150	11,000	20,800	9,973	4,923	1,692	25,725
Indiana	8	454,300	65,800	178,800	147,450	36,100		8,210	4,250	9,430	1,370	11,860
Kansas	14	290,200	78,500	90,100	135,050	15,500		1,700	7,500	3,500	335	13,800
Kentucky	5	101,000	34,000	26,000	29,400				1,900	450		7,500
Louisiana	14	704,100	221,600	133,200	342,150	55,250		33,600	9,145	18,600	335	15,280
Maryland	3	79,500	26,000	6,000	36,000			4,520				22,300
Massachusetts	1	55,000	13,500	15,000	24,000				1,000			10,000
Michigan	14	147,400	27,100	23,950	46,000	18,000	450		2,140		160	9,000
Minnesota	3	22,000			15,000				700			2,500
Mississippi	2	11,100	5,100	2,000					150			3,600
Missouri	1	73,000	7,200	50,000	32,000				1,800		505	4,000
Montana	11	69,300	17,000	19,450	40,800	600			1,850		210	9,100
Nebraska	2	3,200		1,000								
New Jersey	6	449,550	110,800	79,800	211,000	22,000	30,000	5,200	6,800	8,270		23,200
New Mexico	7	23,850	2,500	6,575	6,000	2,000			440			800
New York	5	109,500	13,000	20,350	51,000				650	3,600		2,800
North Dakota	3	37,000			12,500	300			4,365			
Ohio	12	409,100	64,602	141,767	163,100	35,540	13,000	5,900	11,120	4,200	675	15,500
Oklahoma	19	359,800	88,800	110,450	136,000	23,300		8,950	8,820	10,900	800	10,000
Oregon	1	6,500	6,500									6,250
Pennsylvania	12	673,290	179,160	93,162	298,570	71,090	750	8,610	9,016	27,760	25	10,853
Rhode Island	3	13,900	1,750									3,400
South Carolina	1	8,700	6,800									4,500
Tennessee	2	7,000	3,000		2,700				500			
Texas	57	2,310,200	489,100	673,450	824,280	174,750	38,000	80,479	34,475	59,855	267	32,400
Utah	5	76,000	26,500	8,700	39,500				1,200	120		800
Washington	3	44,940	13,500	6,600	20,000	6,000			1,000			2,900
West Virginia	2	7,300		2,550		2,500			100	3,250		
Wisconsin	2	11,000	3,000	1,500		2,600			100			2,000
Wyoming	12	106,925	31,500	25,350	41,500	4,750	1,000	2,425	1,950	650	218	11,370
Total	304	8,639,255	2,065,452	2,445,439	3,280,850	569,330	116,700	227,028	126,619	179,918	8,092	331,695

U. S. Refineries Pass 8½-Million-Barrel Capacity

by John M. McGivern
District Editor

WHILE crude-oil production in 1954 dropped 1.7 per cent, United States refiners boosted their capacities by 2.4 per cent at 8,639,255 bbl. daily.

At the present rate of growth, the United States will be able to refine 9,000,000 bbl. of crude oil daily by the middle of 1956.

The eye-stopper occurs in the vacuum distillation column where the figure of 2,065,452 represents a 70.5 per cent increase. This boost, however, does not show new capacity. It merely reflects a change made in the Journal survey to give a better picture of vacuum operations.

Catalytic cracking and reforming both showed large increases in 1954. Cat cracking jumped 15.9 per cent to 3,280,850 bbl. Its ratio to crude jumped from 34 to 37.9 per cent. In the immediate post-World War II years, the ratio stood at about 20 per cent.

Cat reforming soared 128 per cent to 569,330 bbl. The ratio to crude charging is 6.6 per cent.

Thermal operations continued its postwar dip. From a high of 40 per cent in the years right after the war, the ratio has skidded to 28.2 per cent.

The Journal lists two newcomers this year. One is a fairly new process, the other is an old hand.

The johnny-come-lately is catalytic hydrogenation. So far only a few companies have units; however, many more are planning to build this year. Present capacity is 116,700 bbl. daily.

The other debutante is alkylation. Since 1946, the Government has preferred to keep locations and capacities of the units out of the survey. This year top defense officials have withdrawn past objections. Capacity of the units is 227,028 bbl.

Polymerization hopped up a smart 20.5 per cent, coke capacity rose 5 per cent, and asphalt turtled forward 2.3 per cent. The only decrease, besides the thermal operations, was registered in lubes, where capacity was down 7.6 per cent from 194,792 bbl. to 179,948 bbl.

The increases came despite the closing of 20 refineries during 1954. These operations, nearly all old and thermal plants, had a capacity of 221,460 bbl. Tide Water Associated Oil Co.'s 87,500-bbl. plant at Bayonne, N. J., was the largest casualty. The second in size was Sid Richardson Refining Co.'s 18,000-bbl. Texas City, Tex., operation. However, Tide Water has already announced plans to replace the Bayonne old-timer with a modern 130,000-bbl. refinery at Delaware City, Del.

Report on United States Operating Refineries

. . . Where they are, their capacities, and types of processes

EXPLANATIONS OF ABBREVIATIONS USED IN TABLES

THERMAL OPERATIONS
- C—Cracking
- Ck—Coking
- B-Ck—Batch coking
- D-Ck—Delayed coking
- V—Visbreaking
- R—Naphtha reforming

CATALYTIC REFORMING
- Pf—Platforming
- Hydro—Hydroforming
- F Hyd—Fluid Hydroforming
- FB Hyd—Fixed bed Hydroforming
- Ho—Houdriforming
- Ul—Ultraforming
- Cat—Catforming
- T—Thermofor
- S-B—Sinclair-Baker
- Cy—Cycloversion
- Sv—Sovaforming
- Hyp—Hyperforming

CATALYTIC HYDROGENATION
- Un Hyd—Unifining
- HydF—Hydrofining
- HydT—Hydrotreating
- HydS—Hydrodesulfurization
- Per Hyd—Perco Hydrogenation
- D Hyd—Diesulforming

POLYMERIZATION
- C—Catalytic
- T—Thermal

CATALYTIC CRACKING
- F—Fluid
- T—Thermofor
- Ho—Houdriflow
- Hy—Houdry
- Cy—Cycloversion

ALKYLATION
- S—Sulfuric
- F—Hydrofluoric

ASPHALTS
- S—Straightrun
- O—Oxidized
- M—Other

ALABAMA

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
American Bitumuls & Asphalt Co.:									
Mobile	6,000	6,000							S 4,800 O 900 M 2,300
Hunt Oil Co.:									
Tuscaloosa	5,200	2,700							S 1,100 O 300
Vulcan Asphalt Refining Co.:									
Cordova	1,500								S 300
Warrior Asphalt Corp.:									
Holt	1,750								S 900 O 400
Total	14,450	8,700							11,000

ARKANSAS

Berry Asphalt Co.:									
Stephens	2,000	1,200							S 500
Waterloo	1,500	1,200						L 500	S 600
Henry H. Cross Co.:									
Smackover	6,000	1,200						L 700	S 700
Lion Oil Co.:									
El Dorado	25,000	14,200		F 10,000 T 6,000		S 1,150	C 400	L 1,000	S 3,800
Macmillan Petroleum Corp.:									
Norphlet	4,000	3,000						L 1,000	S 1,000 O 1,000
Pan-Am Southern Corp.:									
El Dorado	34,500	8,000	C 3,500 D-CD 10,000	F (2 units) 18,600		F 1,500	C 450	C 400	
Total	73,000	28,800	13,500	34,600		2,650	850	L 3,200	7,600

CALIFORNIA

Bankline Oil Co.:									
Bakersfield	8,000		C 3,000						
Calstate Refining Co.:									
Long Beach			V 2,500		Hyp 1,000				
Caminol Co.:									
Hanford	5,000		C 650 V 1,000 R 350				C 70		

CALIFORNIA (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Century Oil Co.:									
Signal Hill	5,000								
Douglas Oil Co. of Calif.:									
Bakersfield	8,200		C 4,600		Cat 2,500				
Paramount	6,000								(*)
Santa Maria	3,500								(*)
Edgington Oil Refineries, Inc.:									
Long Beach	6,500								S 2,000
									O 1,900
Oxnard	2,000								S 1,200
Envoy Petroleum Co.:									
Long Beach	3,500								S 1,750
Eureka Refining Corp.:									
Long Beach	4,000 est.								
Fletcher Oil Co.:									
Wilmington			C 5,000				C 80		
General Petroleum Corp.:									
Torrance	128,000	38,000	V 26,000	T 52,000	T 19,000	F 3,700	C 600	C 1,100	
			D-Ck 26,000						
Golden Bear Oil Co.:									
Oildale	3,000							L 1,250	S 1,500
Hancock Oil Co.:									
Signal Hill	14,000		V 11,000	T 6,000			C 500		
Macmillan Petroleum Corp.:									
Long Beach	8,000							L 300	S 2,000
McAllen Refining Co.:									
Huntington Beach	5,000 est.								S 500
Mohawk Petroleum Corp.:									
Bakersfield	11,000		C 1,000		Pf 2,500				
			V 2,500						
Newhall Refining Co.:									
Newhall	3,000								M 125
Oxnard Oil & Refining Co.:									
Oxnard	1,800								S 1,000
Palomar Oil & Refining Corp.:									
Bakersfield	1,300	1,300						L 390	S 580
Richfield Oil Corp.:									
Watson	140,000	60,000	C 25,000	F 63,000		S 7,000	C 2,000		S-O-M 3,000
			V 27,000	T 32,000					
Rothschild Oil Co.:									
Santa Fe Springs	10,000		C 5,000		Pf 1,000		C 150		
Seaside Oil Co.:									
Chrisman	5,500	500							S 500
Shell Oil Co.:									
Martinez	55,000	11,000	C 30,000		Pf 4,500			L 3,100	S 4,200
Wilmington-Dominguez	79,000	45,000	C 36,000	F 25,000	Pf 3,500	S 5,500			
					HydS 12,000				
Socal Oil & Refining Co.:									
Huntington Beach	2,400		C 1,800						
Standard Oil Co. of California:									
Bakersfield	22,000		D-Ck 9,900						M-S-O 1,230
El Segundo	133,200	59,940	R 12,210	F 40,000	Pf 11,100	S 5,984			M-S-O 9,520
			D-Ck 65,400		FB Hyd				
Richmond	181,500	27,750	V 8,350	T 35,500	13,800	S 4,400		L 11,100	12,300
			D-Ck 50,000						
Sunland Refining Corp.:									
Bakersfield	8,000		V 1,200						
Sunset Oil Co.:									
Torrance	9,000		Ck 2,500				C 75		
Superior Asphalt Co.:									
Oxnard	1,600								S 900
The Texas Co.:									
Wilmington	60,000	35,000	C 10,000	F 23,000		S 4,400			
Tide Water Associated Oil Co.:									
Avon	114,000	54,000	C 17,600	F 33,000	Pf 10,000	S 6,000		L 1,670	
			V 27,000		UnHyd				
					10,500				
Union Oil Co. of California:									
Los Angeles	124,000		R 6,300	F 30,000		S 5,000			
			C 36,600	T 17,800					
Maltha	9,000								
Oleum	105,000	6,500	C 49,000						(*)
Orcutt	5,500		V 2,800					L 3,400	
Santa Maria			Ck 21,000						
Wilshire Oil Co., Inc.:			Comb-Ck						
Norwalk	24,000	15,000	15,000	F 6,000		F 2,000	C 600		
Total	1,315,500	353,990	543,260	363,300	R 68,900	43,984	4,075	L 21,210	45,157
					Hyd 22,500			C 1,100	

*Not reported.

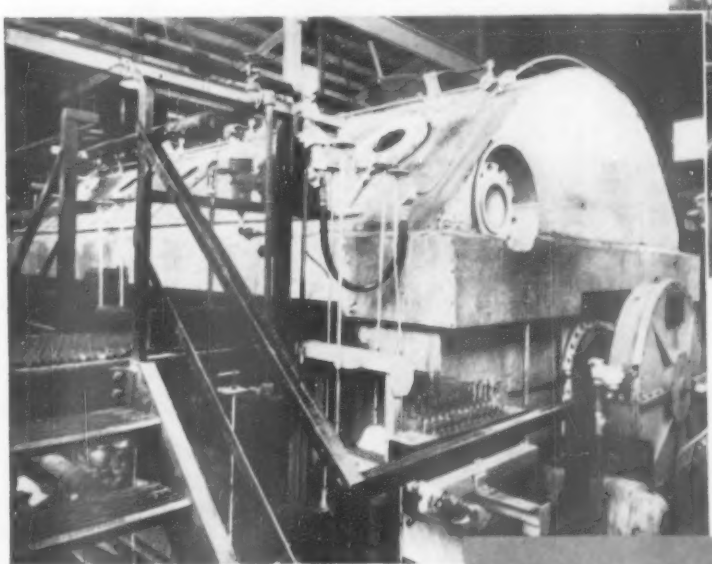
MODERN REFINERY EQUIPMENT

pays dividends . . .

. . . in greater production, higher quality, less maintenance cost and less down time due to failure. CB&I, a pioneer in the manufacture of welded steel plate structures for the petroleum industry, design, engineer, fabricate and erect such structures as Hortonspheres®, Hortonspheroids®, processing towers, and Conkey filters . . . modern refinery structures built to exacting specifications. When you plan welded steel plate structures for your refinery be sure to write our nearest office for information, estimates or quotations.

FLUID CAT CRACKER

CB&I built the reactor-regenerator and catalyst hoppers for the UOP fluid catalyst cracking unit shown above at the Rock Island Refinery Corp., Zionsville, Indiana, refinery.



CONKEY SOLVENT DEWAXING FILTERS

These filters are specifically designed for the clarification filtration of oil solvent mixes for the recovery of slack wax in refinery MEK solvent dewaxing plants. They are also applicable to product wax recovery from recrystallization filtration of slack wax with concurrent removal of product wax and soft waxes from low cold test oils.

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Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

COLORADO

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Bay Petroleum Corp.:									
Denver	12,000	4,700	V 4,700	F 3,600			C 300		
Continental Oil Co.:									
Denver	11,400		C 2,150	T 4,100			C 450		
Empire Petroleum Co.:									
Denver	7,000	4,000							S 2,000
Oriental Refining Co.:									
Alamosa	1,000		C 400						
Denver	4,000		C 1,500						
Skelly Oil Co.:									
Denver	1,650		C 800						
Wesco Refining Co.:									
Rangely	1,700		V 200						
Total	38,750	8,700	9,750	7,700			750		2,000

DELAWARE

The Texas Co.:									
Claymont	3,500	1,750							1,500
Total	3,500	1,750							1,500

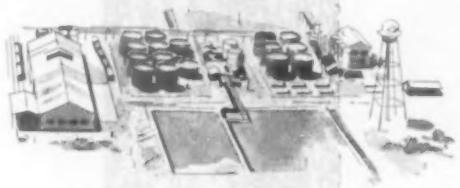
GEORGIA

American Oil Co.:									
Savannah	6,500								S 3,000
Total	6,500								3,000

ILLINOIS

Advance Refining Co., Inc.:									
Centralia	2,500			Cy 650					
Calumet Refining Co.:									
Burnham	1,200	1,200						L 750	S 225
Henry H. Cross Co.:									
Colmar	1,000								
Clark Oil & Refining Corp. (formerly Petco Corp.):									
Blue Island	20,000	8,500	C 1,500 V 1,500	Ho 8,000	Pf 5,500		C 600		M 1,400
Illinois Farm Supply Co. (formerly Pana Refining Co.):									
Pana	5,000		C 2,500		Pf 650		C 150		M 1,100
Ohio Oil Co.:									
Robinson	40,000	(*)	C 9,000 D-Ck 6000	F 18,500	Ho 8,000	S 1,500	C 1,500	C 250	
Pure Oil Co.:									
Lemont	48,000	(*)	C 3,000 R 6,000	F 23,000		F 1,600	C 2,000		S 5,500
Shell Oil Co.:									
Wood River	170,000	68,000	C 15,500 R 20,000 B-Ck 15,000	F 55,000	Pf 16,000 Hyd S 11,000	S 9,000	C 1,200	L 3,100 C 800	S 3,500
Sinclair Refining Co.:									
Wood River	28,000	15,000	C 6,000	F 11,000	Cy 6,000		C 800		S 1,500 O 500
Socony-Vacuum Oil Co., Inc.:									
East St. Louis	42,200	(†)	C 3,300 R 2,775 Ck 9,900	T 29,100		F 1,500	C 500	C 266	
Standard Oil Co. (Ind.):									
Wood River	50,000	6,000	C 10,200 V 3,400 R 7,060 B-Ck 3,740	F 16,000		S 4,000	C 123	L 1,073 C 126	S 2,500 O 2,500 M 1,800
The Texas Co.:									
Lawrenceville	50,000	15,000	C 12,000	F 30,000			C 2,500		S 2,200
Lockport	65,000	13,500	C 15,000 Ck 9,500	F 30,000		S 3,200	C 600	C 250	S 3,000
Total	522,900	127,200	162,875	221,250	R 36,150 Hyd 11,000	20,800	9,973	L 4,923 C 1,692	25,725

*Integrated with atmospheric distillation. †Not reported.



PETRO-CHEMICAL PLANT in Texas to produce ethylene from natural gas by the owner's process.

GENERATING PLANT, one of three of 66,000 KW each, installed for electric utility company in Southwest.

ORGANIC CHEMICAL PLANT to produce insecticides—DDT and BHC—located in the State of Alabama.

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AND SHARP PENCILS

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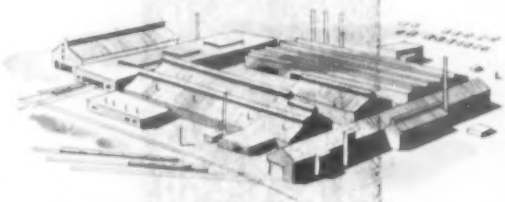

STEEL MILL facilities expanded through contract with Brown & Root in excess of $70,000,000.

PRESSURE MAINTENANCE plant for Venezuelan gas reservoir built in 62 ft. of water with 50,000 h.p.

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BROWN & ROOT, S. A., Panama City, Panama
BROWN & ROOT, INC., One Wall St., New York 5, N. Y.

INDIANA

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Berry Asphalt Co.:									
Waterloo	6,000								(*)
Cities Service Oil Co.:					F Hyd				
East Chicago	52,000		D-Ck 15,000	F 23,500	13,000	S 2,560		C 440	
Indiana Farm Bureau Co-Op Association, Inc.:									
Mount Vernon	9,000	3,800	C 3,000	F 3,750			C 300		
R. J. Oil & Refining Co.:									
Princeton	2,500				Pf 700				
Rock Island Refining Corp.:									
Rock Island	14,800	4,000	V 6,000	F 8,200	Pf 2,400		C 500		
Sinclair Refining Co.:									
East Chicago	110,000	44,000	C 10,000 V 9,000 R 13,000	F 34,000		S 650	C 2,450	L 2,750	S 4,000
Socony-Vacuum Oil Co., Inc.:									
East Chicago	40,000	(*)	C 10,500	T 18,000			(*)		(*)
Standard Oil Co.:					FB Hyd				
Whiting	220,000	14,000	C 42,000 V 14,000 R 15,300 Ck 41,000	F 60,000	14,000	S 5,000	C 1,000	L 6,680 C 930	S 800 O 6,800 M 260
Total	454,300	65,800	178,800	147,450	30,100	8,210	4,250	L 9,430 C 1,370	11,860

*Not reported.

KANSAS

Anderson-Prichard Oil Corp.:									
Arkansas City	15,000	5,500	C 3,500	F 5,500	Cy 4,000		C 500		S 800
Century Refining Co.:									
Shallow Water	5,500	2,500	C 2,000 R 1,500				C 100		S 1,000 M 200
Chanute Refining Co.:									
Chanute			V 750						
Cooperative Refining Association:									
Coffeyville	25,000	6,500	C 4,500 R 1,000	F 7,000			C 600	L 1,500	S 1,500
Phillipsburg	10,000	5,000		F 4,250			C 400		S 1,400
Derby Refining Co.:									
Wichita	24,000	8,000	C 3,000	T 8,000			C 500		S 1,500 O 500
El Dorado Refining Co.:									
El Dorado	12,500	5,000	C 1,000	F 5,300			C 1,200		S 1,500 O 400
M.F.A. Oil Co.:									
Chanute	2,000		C 1,150		Cy 1,000				
National Co-Op Refinery Assn.:									
McPherson	27,500	11,000	C 2,000 D-Ck 11,000	F 16,000			C 1,000	C 250	
Phillips Petroleum Co.:									
Kansas City	55,000	15,000	V 4,500 R 7,800	F 38,000			C 1,500	L 2,000	S 1,500
Skelly Oil Co.:									
El Dorado	45,000	12,000	C 12,000 R 5,000	F 16,000	Pf 7,500		C 1,200		S 3,000
Socony-Vacuum Oil Co., Inc.:									
Augusta	31,700	(*)	C 8,300	T 18,000	Sv 3,000	F 700			(*)
Standard Oil Co. (Ind.):									
Neodesha	22,000		C 5,400 R 2,600 B-Ck 5,100	F 9,000		S 1,000		C 85	M 500
Vickers Petroleum Co., Inc.:									
Potwin	15,000	8,000	C 2,500 V 4,000 R 1,500	T 8,000			C 500		
Total	290,200	78,500	90,100	135,050	15,500	1,700	7,500	L 3,500 C 335	13,800

*Not reported.

KENTUCKY

Ashland Oil & Refining Co.:									
Catlettsburg	63,000	18,000	C 5,000 R 2,000	T 26,000			C 1,000	L 450	O 4,000

KENTUCKY (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Louisville	11,000		C 1,000 V 4,000						
Louisville Refining Co.:									
Louisville	7,500	4,000	C 2,500 R 1,000	F 3,000			C 400		
Sohio Petroleum Co.:									
Covington	18,000	12,000	C 7,000 R 3,500				C 500		O 3,500
Somerset Refinery Co.:									
Somerset	1,500			Cy 400					
Total	101,000	34,000	26,000	29,400			1,900	L 450	7,500

LOUISIANA

Bay Petroleum Corp.:									
Chalmette	20,000	10,600	V 10,600	F 8,000			C 800		
Bayou State Oil Corp.:									
Hosston	1,000	600						L 500	S 250
Breaux Bridge Oil Ref. Co., Inc.:									
Anse La Butte	1,600		C 1,200						
Calumet Refining Co.:									
Princeton	900							L 600	O 250
Canal Refining Co.:									
Church Point	1,200				Cat 750				
Cit-Con Corp.:									
Lake Charles		26,000						L 9,600	
Cities Service Refining Corp.:					F Hyd				
Lake Charles	175,000	26,000	C 10,000	F 86,000	18,000	S 12,000			
Clark Oil & Refining Corp (formerly Petco):									
Marrero	7,500		C 2,000 R 1,000				C 125		
Continental Oil Co.:									
Westlake	51,100		C 5,800 R 2,600	T 22,150	Pf 5,600	S 2,400	T 660 C 660		
Esso Standard Oil Co.:					F Hyd				
Baton Rouge	326,600	118,400	C 36,500 V 20,000 R 9,000	F 154,000	27,800	S 12,500	C 5,000	L 8,500	S 9,800 O 200
Evangeline Refining Co.:									
Jennings	1,700				Cy 450				
Ingram Oil & Refining Co.:									
Meraux	10,000	6,000		F 7,000			C 600		
Pan-Am Southern Corp.:					F Hyd				
Destrehan	32,500	3,000	D-Ck 10,000	F 17,000	2,650	S 2,500		C 335	S 1,700 O 330 M 450
Shell Oil Co.:									
Norco	75,000	31,000	C 22,500 R 2,000	F 48,000		S 4,200	C 1,300		S 1,800 O 200 M 300
Total	704,100	221,600	133,200	342,150	55,250	33,600	9,145	L 18,600 C 335	15,280

MARYLAND

American Bitumuls & Asphalt Co.:									
Baltimore	*7,500	(†)	V 6,000						S 6,000 M 4,300
American Oil Co.:									
Baltimore	10,000								5,000
Esso Standard Oil Co.:									
Baltimore	62,000	26,000		F 36,000		S 4,520			S 5,000 O 2,000
Total	79,500	26,000	6,000	36,000		4,520			22,300

*Combination atmospheric and vacuum unit. †Atmospheric unit operated as visbreaker during December, January, and February for production of Bunker C fuel oil.

MASSACHUSETTS

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Esso Standard Oil Co.:									
Everett	55,000	13,500	V 10,000 R 5,000	F 24,000			C 1,000		S 7,500 O 2,500
Total	55,000	13,500	15,000	24,000			1,000		10,000

MICHIGAN

Aurora Gasoline Co.:									
Detroit	35,000	15,000	C 2,000	F 12,500	Pf 7,000		C 750		S 5,000
Elsie	6,500		V 6,000		Pf 1,500				
Muskegon	9,000		C 3,000		Pf 2,200		C 150		
Bay Refining Corp.:									
Bay City	10,000	2,000		T 7,000			C 950		
Crystal Refining Co. of Carson City, Inc.:									
Carson City	6,200								
Lakeside Refining Co.:									
Kalamazoo	3,500			Cy 1,000	Cy 1,000				
Leonard Refineries, Inc.:									
Alma	10,500	6,500	R 2,000	T 7,500			C 100		S 2,500 O 1,500
Marvel Refining Co.:									
Grand Rapids	2,000								
Mid-West Refineries, Inc.:									
Alma	10,000	C 3,600			Pf 2,500		C 140		
Naph-Sol Refining Co.:									
Muskegon	6,000		C 2,500		Pf 1,000		T 50		
Osceola Refining Co., Inc.:									
Reed City	2,500								
Petroleum Specialties, Inc.:									
Flat Rock	6,500				Pf 1,000				
Roosevelt Oil & Refining Corp.:									
Mount Pleasant	7,500				Pf 1,800 Hyd T 450				
Socony-Vacuum Oil Co., Inc.:									
Trenton	32,200	(*)	C 3,950 Ck 4,500	T 18,000				C 160	
Total	147,400	27,100	23,950	46,000	R 18,000 Hyd 450		2,140	C 160	9,000

*Not reported.

MINNESOTA

International Refineries, Inc.:									
Wrenshall	12,000			F 5,000			C 200		
Northwestern Refining Co.:									
New Brighton	3,000								
St. Paul Park	7,000			F 10,000			C 500		S 2,500
Total	22,000			15,000			700		2,500

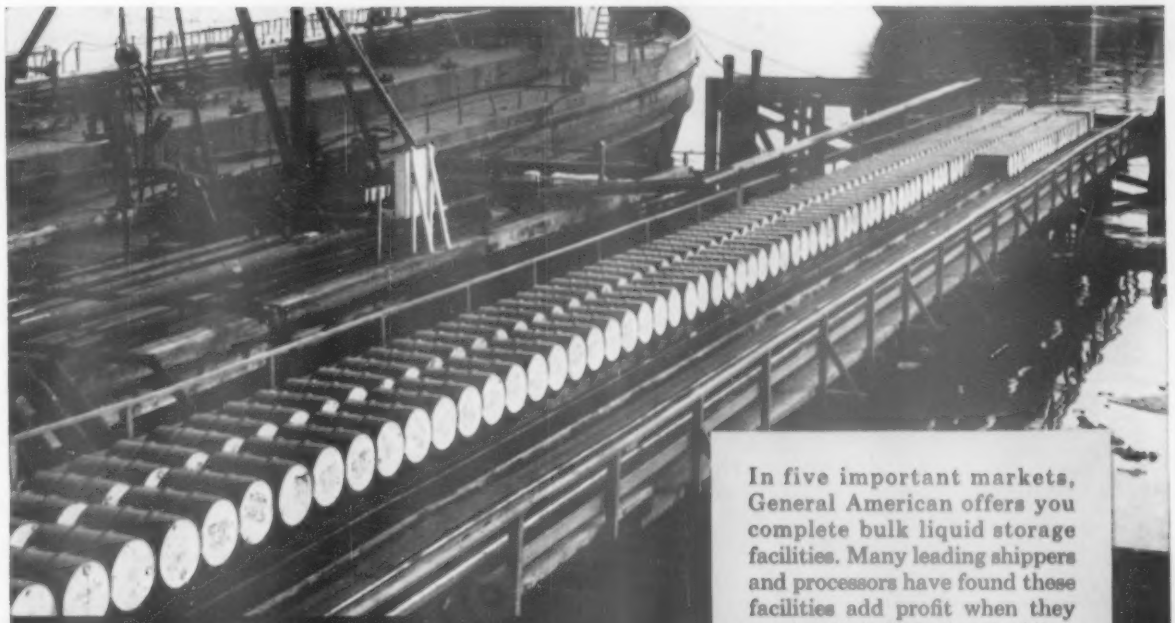
MISSISSIPPI

Paluxy Asphalt Co.:									
Yazoo City	5,600	2,000	C 2,000				C 150		S 500 O 500
Southland Co.:									
Sandersville	5,500	3,100							S 2,600
Total	11,100	5,100	2,000				150		3,600

MISSOURI

Standard Oil Co. (Ind.):									
Sugar Creek	73,000	7,200	C 19,600 R *6,000 B-Ck 5,500 D-Ck 24,900	F 32,000			C 1,800	C 505	S 2,000 O 1,000 M 1,000
Total	73,000	7,200	50,000	32,000			1,800	505	4,000

*If this capacity is utilized, the thermal cracking capacity is reduced by 6,000 bbl.



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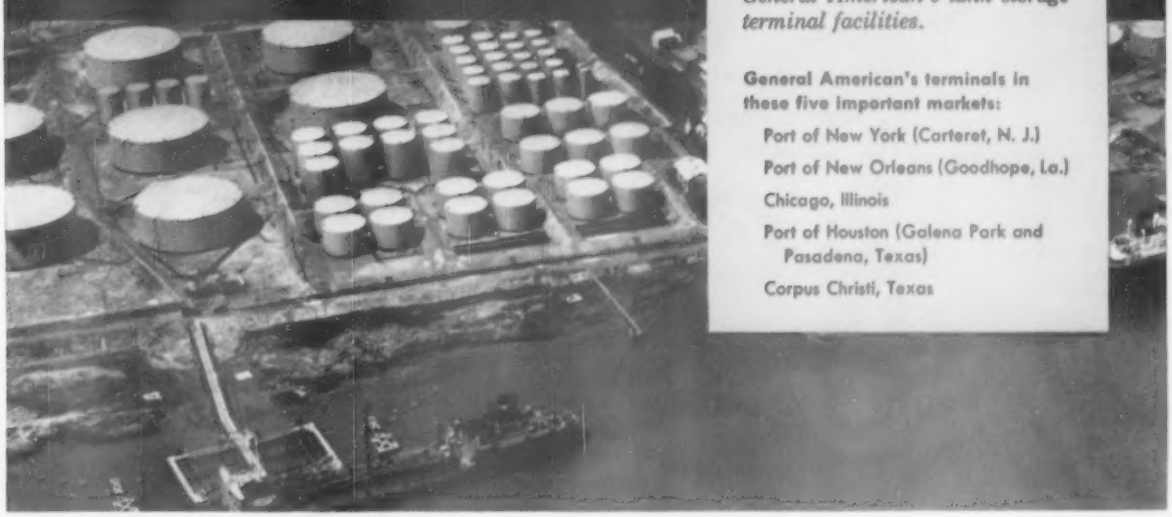
- Chicago, Illinois
- Port of Houston (Galena Park and Pasadena, Texas)
- Corpus Christi, Texas



MONTANA

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Big West Oil Co. of Montana:									
Kevin	2,200		C 1,250						
Carter Oil Co.:									
Billings	25,000	9,000	F-Ck 3,800	F 25,000			C 600	C 210	S 5,000
Continental Oil Co.:									
Billings	9,700			F 4,800			C 450		
Farmers Union Central Exchange, Inc.:									
Laurel	15,000	7,200	V 5,000	F 11,000			C 600		S 3,250
Eugene Hunt:									
Winnett	300								
Modern Oil Co., Inc.:									
Shelby	1,000								
Phillips Petroleum Co.:									
Great Falls	2,500	800	C 1,200				C 30		M 250
Jet Fuel Refinery Co.:									
Mosby	600								
The Texas Co.:									
Sunburst	8,000		C 5,000				C 100		
Union Oil Co. of California:									
Cut Bank	4,000		C 3,200		Cat 600		C 70		
Unity Petroleum Corp.:									
Kalispell	1,000								S 600
Total	69,300	17,000	19,450	40,800	600		1,850	C 210	9,100

NEBRASKA

Cooperative Refinery Association:									
Scottsbluff	2,200		C 1,000						
Searle Petroleum Co.:									
Salem	1,000								
Total	3,200		1,000						

NEW JERSEY

California Oil Co.:									
Barber	72,000		V 5,000	Ho 28,000	Pf 10,000	S 2,100	C 300		S 5,500
Cities Service Oil Co.:									
Linden	15,000								S 3,300 O 2,900 M 1,300
Esso Standard Oil Co.:									
Bayonne	26,500	*15,000						L 500	S 8,200 O 2,000
Linden	170,500	73,800	V 28,800 R 10,300 C 8,500	F 118,000	Hyd F 30,000		C 4,000		
Socony-Vacuum Oil Co., Inc.:									
Paulsboro	105,550	(†)	V-R 18,200	T 30,000		S 1,500	(†)	L 7,770	
The Texas Co.:									
Westville, N. J.	60,000	22,000	R 9,000	F 35,000	Pf 12,000	S 1,600	C 2,500		
Total	449,550	110,800	79,800	211,000	R 22,000 Hyd 30,000	5,200	6,800	8,270	23,200

*Integral with atmospheric distillation. †Not reported.

NEW MEXICO

Continental Oil Co.:									
Artesia	4,300		C 1,875						
Farmington	800								
Famariss Oil & Refining Co.:									
Monument	1,750				Pf 650				
Malco Products, Inc.:									
Bloomfield	1,000								
Malco Refineries, Inc.:									
Prewitt	2,500		C 1,500		Cat 750		C 100		
McNutt Oil & Refining Co., Inc.:									
Brickland	3,500		C 1,200		Pf 600		C 40		
New Mexico Asphalt & Ref. Co.:									
Artesia	10,000	2,500	C 2,000	T 6,000			C 300		S 800
Total	23,850	2,500	6,575	6,000	2,000		440		800

NEW YORK

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Ashland Oil & Refining Co.:									
Buffalo	25,000	10,000	R 3,000	F 15,000			C 550		O 2,500
Gulf Oil Corp.:									
Staten Island	18,800								
Sinclair Refining Co.:									
Wellsville	9,000	3,000	C 3,000 R 5,000				C 100	L 2,500	S 300
Socony-Vacuum Oil Co., Inc.:									
Brooklyn	27,800	(*)	C 3,850	T 18,000					
Buffalo	28,900	(*)	R 5,500	T 18,000				L 1,100	
Total	109,500	13,000	20,350	51,000			650	3,600	2,800

*Not reported.

NORTH DAKOTA

Queen City Oil & Refining Co.:									
Dickinson	2,000								
Williston Basin Refining Corp.:									
Williston	2,000				Cat 300				
Standard Oil Co. (Ind.):									
Mandan	33,000			F 12,500			C 4,365		
Total	37,000			12,500	300		4,365		

OHIO

American Bitumuls & Asphalt Co.:									
Cincinnati	8,000	8,000							S 6,000
Ashland Oil & Refining Co.:									
Canton	25,000		V 11,000	F 15,000			C 650		
Findlay	16,000	8,000	C 2,500 V 3,000 R 1,500				C 200	L 900	O 2,500
Dewese Oil Refinery:									
Weston	1,500								
Gulf Refining Co.:									
Cleves	33,300	8,320	C 10,880 R 2,775	F 13,320			C 1,665		
Toledo	44,400	6,882	C 11,877 R 1,665	F 13,400			C 1,665		
Pure Oil Co.:									
Newark	17,500		C-V 9,000	F 4,500	S-B 3,000 FB-Hyd		C 200		
Toledo	39,400	4,400	C-V 19,700 D-Ck 5,000	F 11,600	5,000		C 1,270	C 175	
Standard Oil Co. of Ohio:									
Cleveland	55,000	18,000	C 12,000 R 10,000	T 23,000			C 1,000	L 1,600	O 7,000
Lima	50,000	11,000		F 29,000	Pf 12,000 UnHyd 13,000		C 800	L 1,700 C 320	
Toledo	28,000		C 8,000 R 7,000 D-Ck 7,000			S 5,900	C 700	C 180	
Sun Oil Co.:									
Toledo	91,000		R 18,870	Ho 35,520 Hy 17,760	Pf 15,540		C 2,970		
Total	409,100	64,602	141,767	163,100	R 35,540 Hyd 13,000	5,900	11,120	L 4,200 C 675	15,500

OKLAHOMA

Allied Materials Corp.:									
Stroud	2,500	1,500							S 1,000 O 1,000
Anderson-Prichard Oil Corp.:									
Cyril	11,000	5,000	C 5,000		Cat 1,000		C 250		S 1,200 O 500
Bell Oil & Gas Co.:									
Grandfield	7,000		C 4,000		Pf 1,500		C 100		
Ben Franklin Refining Co.:									
Ardmore	10,000	5,000	C 4,000	F 5,000			C 500		S 1,000

OKLAHOMA (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Champlin Refining Co.:									
Enid	22,000	9,000	C 6,000 V 4,000 R 3,500				C 500	L 1,200	
Cities Service Oil Co.:									
Ponca City	23,000	7,000	C 800 R 1,950 B-Ck 1,950	F 10,000				C 100	
Continental Oil Co.:									
Ponca City	58,000	10,800	C 6,500 R 4,000 D-Ck 12,500	T 33,500	Pf 5,000	F 5,000	C 700	L 2,100 C 400	
Deep Rock Oil Corp.:									
Cushing	19,000	3,000	V 6,400	F 7,000			C 400	L 1,100	S 500
Johnson Oil Refining Co.:									
Cleveland	7,000		C 3,400		Pf 1,800		C 200		
Kerr-McGee Oil Industries, Inc.:									
Wynnewood	15,000	6,000	V 1,500	F 10,000			C 500		S 3,000
Mercury Oil Refining Co.:									
Oklahoma City	5,000		C 1,400						
Mid-Continent Petroleum Corp.:									
Tulsa	64,000	16,500	C 3,500 V 6,000	F 22,000	Cat 7,500	S 2,400	C 2,200	L 6,500	O 600
Midland Cooperatives, Inc.:									
Cushing	12,000		V 6,000	F 5,500			C 400		
Monarch Refineries, Inc.:									
Oklahoma City	1,000								S O 1,000
Phillips Petroleum Co.:									
Okmulgee	16,000	3,000	V 2,800	T 10,000			C 700		M 200
Sunray Oil Corp.:									
Allen	13,000						C 250		
Duncan	34,000	13,000	D-Ck 9,000	F 18,000	Pf 5,000	F 1,550	C 500	C 300	
The Texas Co.:									
West Tulsa	35,000	9,000	C 9,000 R 5,000	F 15,000			C 1,500		
Wilcox Oil Co.:									
Bristow	5,300		C 2,250		Pf 1,500		C 120		
Total	359,800	88,800	110,450	136,000	23,300	8,950	8,820	L 10,900 C 800	10,000

OREGON

American Bitumuls & Asphalt Co.:									
Portland	6,500	6,500							S 4,200 O 900 M 1,150
Total	6,500	6,500							6,250

PENNSYLVANIA

Ashland Oil & Refining Co.:									
Freedom	6,000	2,000						L 800	
Atlantic Refining Co.:									
Philadelphia	158,600	44,400	C 11,600	F 65,500	Cat 16,650	S 5,500	C 2,110	L 5,500	S 6,600 O 700 M 1,665
Gulf Oil Corp.:									
Philadelphia	215,340	77,700	C 7,992 R 12,400	F 94,350	Pf 17,750	S 3,110	C 3,996	L 1,110	
Kendall Refining Co.:									
Bradford	5,000		C-Ck 1,500		Pf 1,550		C 100	L 1,200 C 25	
Pennsylvania Refining Co.:									
Karns City	1,400	560						L 300	
Pennzoil Co.:									
Rouseville	10,000	3,500	C 1,600 R 2,240	F 3,600			T 960	L 2,500	
Quaker State Oil Refining Corp.:									
Emlenton	3,000	1,500	C 750 R 600		Pf 1,000			L 1,700	
Sinclair Refining Co.:									
Marcus Hook	100,000	45,000	C 5,000 V 18,000	F 36,000	S-B 16,000		C 1,850		
Sonneborn, L., & Sons:									
Franklin	2,000								S 500
Sun Oil Co.:									
Marcus Hook	160,950		R 26,640	T 22,200 Hy 76,000	Ho 15,540			L 13,000	S 888

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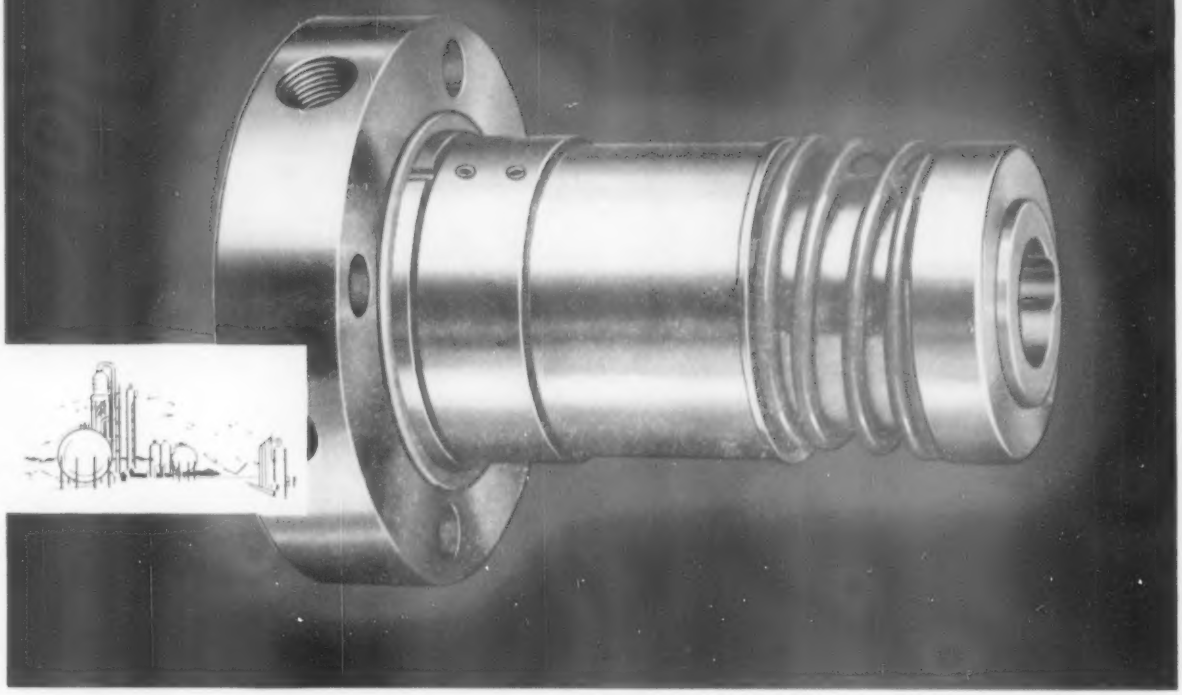

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PENNSYLVANIA (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
United Refining Co.:									
Warren	8,500	4,500	C 1,800 V 2,000		Cat 2,600 UnHyd 750			L 1,000	O 500
Wolf's Head Refining Co., Inc.:									
Reno	2,500		C 520 R 520	F 920				L 650	
Total	673,290	179,160	93,162	298,570	R 71,090 Hyd 750	8,610	9,016	L 27,760 C 25	10,853

RHODE ISLAND

American Bitumuls & Asphalt Co.:									
East Providence	*1,500								S 750 M 1,150
Socony-Vacuum Oil Co., Inc.:									
East Providence	8,900	(†)							(†)
The Texas Co.:									
Providence	3,500	1,750							M-S-O 1,500
Total	13,900	1,750							3,400

*Two-stage atmospheric and vacuum unit. †Not reported.

SOUTH CAROLINA

Esso Standard Oil Co.:									
Charleston	8,700	6,800							S 4,100 O 400
Total	8,700	6,800							4,500

TENNESSEE

Delta Refining Co.:									
Memphis	6,000	3,000		T 2,700			C 500		
Southern Oil Service:									
Nashville	1,000								
Total	7,000	3,000		2,700			500		

TEXAS

American Liberty Oil Co.:									
Mount Pleasant	16,000	9,500	V 2,000	T 7,000			C 375		S 5,450 O 550
Atlantic Refining Co.:									
Port Arthur	61000			F 26,000	Cat 7,200		C 100		
Bryson Pipeline & Refining Co.:									
Bryson	2,000							L 500	
Col-Tex Refining Co.:									
Colorado City	12,000	6,000	C 4,000		Pf 1,500		C 80		S 1,500 O 500
Continental Oil Co.:					PerHyd				
Wichita Falls	8,800		C 3,900 R 1,350		2,000		T 550 C 200		
Corpus Christi Refining Co.:									
Corpus Christi	8,500	2,000							
Palestine	3,500						T 150		
Cosden Petroleum Corp.:									
Big Spring	25,000	9,000	C 7,500	F 10,000	Pf 4,500	F 2,064	C 900		S 3,500 O 350 M 1,000
Crown Central Petroleum Corp.:									
Houston	30,000		C 8,500 R 1,000	T 15,500	Ho 5,000	F 3,300	C 1,000		
Dallawax Co.:									
Kilgore	500								
Danaho Refining Co.:									
Pettus	4,500		C 1,000		Pf 1,000		C 50		
Eastern States Petroleum Co., Inc.:									
Houston	50,000	24,000	V 16,000	F 16,500	Pf 6,500 UnHyd 6,000	S 3,500	C 1,200		

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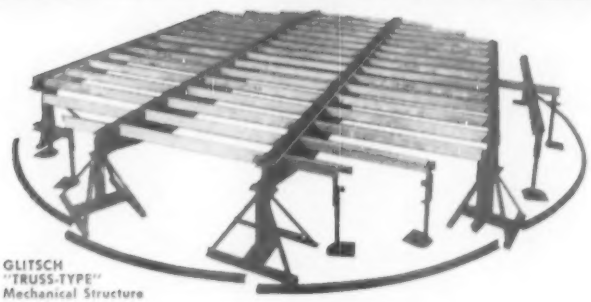

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TEXAS (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Eddy Refining Co.:									
Houston	2,000								
Flint Chemical Co.:									
San Antonio	300							L 250	
G & B Oil Co.:									
Graham	700								
Gladewater Refining Co.:									
Gladewater	2,500		C 1,000		Cat 700		C 100		
Gulf Oil Corp.:									
Port Arthur	272,000	72,000	C 73,000 R 20,000	F 59,940 T 27,750 Hy 9,990		S 4,440	C 4,000	L 13,330	
Humble Oil & Refining Co.:									
Baytown	309,000	(*)	C 22,000	F 107,800	FbHyd 27,000 HydF 30,000	S 9,350	T 3,700	L 12,400	S 2,500
			V 19,500				C 4,600		
Magnolia Petroleum Co.:									
Beaumont	200,000	49,000	C 5,600 V 57,700 R 12,200	T 78,500 Hy 12,800		S 5,200	T 1,100	L 7,100	
McBride Oil & Gas Co.:									
Brownsville	7,500	5,000							S 3,500
La Blanca	3,500				Cat 1,000				
McMurrey Refining Co.:									
Tyler	25,000		C 3,500 D-Ck 8,300	F 7,500	Pf 5,500		C 800	C 67	
Monarch Refining Co.:									
San Antonio	2,500								
Onyx Refining Co.:									
Hawley	7,000		C 4,500 V 4,500 R 1,250		Pf 650		C 130		
Pan American Refining Corp.:									
Texas City	160,000	27,000	C 75,000 R 10,500	F 70,000	UI 21,000 FbHyd 7,500	S 9,000	C 4,800		S 5,500
Panhandle Oil Corp.:									
Wichita Falls	8,000		C 1,750	F 1,500			C 200		
Peerless Tank Cleaning Co.:									
Kilgore	1,000								
Petroleum Products Refining & Producing Co.:									
Kilgore	1,500		C 1,000						
Petrolite Corp., Ltd.:									
Kilgore	700								
Phillips Petroleum Co.:									
Phillips	68,000	17,000	C 7,200 V 7,200 R 8,000	F 38,000 Cy 11,000		F 6,400	C 250		
Sweeny	79,000	17,000	C 5,000	F 26,000	Pf 16,000	F 5,000			
Phoenix Refining Co.:									
San Antonio	3,500								
Pontiac Refining Corp.:									
Corpus Christi	30,000	6,400		F 6,200	Pf 5,800		C 600		
Premier Oil Refining Co. of Texas:									
Baird	2,500		C 1,200						
Fort Worth	7,500	1,700	C 2,200	F 3,000	Pf 1,700		C 290		
Longview	4,200		C 2,200				C 75		
Pure Oil Co.:									
Nederland	67,000	20,000	C-V-R 15,200	F 17,750 T 9,800		S 2,925	T 800 C 825	L 2,000	
Rado Refining Co.:									
McAllen	2,000								
Republic Oil Refining Co.:									
Texas City	42,000	19,000	C 10,000	F 16,000	Pf 6,000		C 1,400		
Shamrock Oil & Gas Corp.:									
Sunray	12,000	2,000	C 2,000 R 2,000	Ho 6,500		S 2,000			S 500
Shell Oil Co.:									
Houston	125,000	40,000	C 31,000 R 14,000	F 35,000	Pf 15,000	S 4,600		L 3,100	S 500
Sinclair Refining Co.:									
Corpus Christi	28,000		C 7,000 R 3,000	Hy 12,000		F 1,700			
Houston	125,000	43,000	C 8,000 V 14,000 R 12,000	F 40,000 T 10,000		S 2,400		L 4,225	
Skelly Oil Co.:									
Longview	7,000		C 3,300		Pf 1,800		C 100		

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TEXAS (Continued)

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Southwestern Oil & Refining Co.:									
Corpus Christi	43,000	9,000		F 7,500	Cy 5,000		C 500		S 900
Standard Oil Co. of Texas:									
El Paso	30,000	10,000	D-Ck 8,000	Ho 14,000		S 1,400			
Suntide Refining Co.:									
Corpus Christi	45,000	10,000		F 17,500		F 3,000	C 850		
Delhi-Taylor Oil Co.:									
Corpus Christi	40,000		V 2,400	T 10,250	Pf 6,000		C 550		
Delhi-Taylor Oil & Gas Co. and Mayfield Minerals, Inc. (Taylor, operator):									
Port Isabel	12,000				Pf 400				
Texas City Refining, Inc.:									
Texas City	30,000	8,500	V 4,000	Ho 18,000		F 1,400			
The Texas Co.:									
Amarillo	15,000		C 2,000	F 8,000	Pf 4,500	S 800	C 200		
El Paso	10,000		C 2,000	F 7,000	Pf 3,500		C 500		
Port Arthur	210,000	60,000	C 105,000 R 22,000 Ck 7,000	F 60,000	Pf 20,000	S 12,000	C 3,500	L 16,000 C 200	
Port Neches	40,000	22,000							S-M-O 6,000
Three Rivers Refinery:									
Three Rivers	1,500							L 750	O 150
Tydal Co.:									
Gainesville	2,000							L 200	
Wickett Refining Co.:									
Wickett	4,000								
Total	2,310,200	489,100	673,450	824,280	R 174,750 Hyd 38,000	80,479	34,475	L 59,855 C 267	32,400

*Not reported.

UTAH

—UTAH—									
Phillips Petroleum Co.:									
Woods Cross	12,500	3,000		T 10,000			C 400		S 800
Salt Lake Refining Co.:									
Salt Lake City	30,000	23,500		Ho 13,000					
Uinta Oil Refining Co.:									
Jensen	1,500								
Utah Oil Refining Co.:									
Salt Lake City	29,000		C 7,200	F 16,500			C 800	L 120	
Western States Refining Co.:									
North Salt Lake City	3,000		C 1,500						
Total	76,000	26,500	8,700	39,500			1,200	120	800

WASHINGTON

American Bitumuls & Asphalt Co.:									
Richmond Beach	3,500	3,500							S 2,600 O 300
General Petroleum Corp.:									
Ferndale	37,000	10,000	V 6,600	T 20,000	SV 6,000		C 1,000		
Union Oil Co. of California:									
Edmonds	4,440								(*)
Total	44,940	13,500	6,600	20,000	6,000		1,000		2,900

*Not reported.

WEST VIRGINIA

Elk Refining Co.:									
Falling Rock	4,500		1,200		Pf 1,500		C 100	L 2,650	
Quaker State Oil Refining Corp.:									
St. Marys	2,800		C 750 R 600		Pf 1,000			L 600	
Total	7,300		2,550		2,500		100	3,250	

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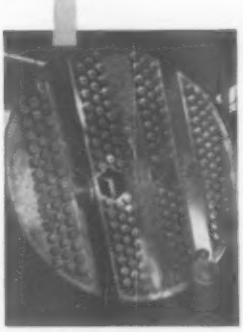

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WISCONSIN

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (L/d.)	Asphalt
Lake Superior Refining Co.: Superior	6,000	3,000	C 1,500		Pf 1,000		T 100		S 1,000 O 1,000
Wisconsin Oil Refining Co., Inc.: Sheboygan	5,000				Cy 1,600				
Total	11,000	3,000	1,500		2,600		100		2,000

WYOMING

Crook County Refinery: Sundance	175								
Continental Oil Co.: Glenrock	4,100		2,200				C 125		
Empire State Oil Co.: Thermopolis	5,000								
Frontier Refining Co.: Cheyenne	10,000	2,500	C 2,500 Ck 3,700	F 8,500			C 400		S 1,400
Husky Oil Co.: Cody	*5,500	4,000			Cat 1,000 DHyd 1,000				S 2,000 O 500 M 500
Ohio Oil Co.: Lovell	*6,000			Cy 700					S 1,800
Pilot Oil Co.: Morton	250								
Sinclair Refining Co.: Sinclair	25,000	9,000	C 2,000 R 2,000	F 10,000		S 1,700	C 350		S 750
Sioux Oil Co.: Newcastle	4,000		C 2,000				C 75		
Socony-Vacuum Oil Co., Inc.: Casper	8,900	(†)		T 7,550			C 500		S 1,090
Standard Oil Co. (Ind.): Casper	21,000	7,000	C 4,450 B-Ck 2,500	F 8,750	UI 3,750	S 725		L 650 C 118	S 115 O 30 M 1,685
The Texas Co.: Casper	17,000	9,000	R 1,500 Ck 2,500	F 6,000			C 500	C 100	S-M-O 1,500
Total	106,925	31,500	25,350	41,500	R 4,750 Hyd 1,000	2,425	1,950	L 650 C 218	11,370

*Combination atmospheric and vacuum unit. †Not reported.

Shutdown Plants in United States Since Last Journal Survey

Company and plant location—	Cap., bbl. per day
CALIFORNIA	
Tide Water Associated Oil Co., Watson	15,000
Western Asphalt & Refining Co., Santa Maria (bought by Douglas Oil Co. Refining operation suspended)	1,500
LOUISIANA	
Stanolind Oil & Gas Co., Superior. (To close April 1)	7,000
MICHIGAN	
Pure Oil Co., Midland	4,700
NEBRASKA	
Sioux Oil Co., Chadron	600
NEW JERSEY	
Tide Water Associated Oil Co., Bayonne	87,500
NEW YORK	
Socony-Vacuum Oil Co., Inc., Olean	7,150
OKLAHOMA	
Peppers Refining Co., Oklahoma City	2,500
Tide Water Associated Oil Co., Drumright	15,000
PENNSYLVANIA	
Gulf Oil Corp., Neville Island	14,430
TEXAS	
Gulf Oil Corp., Fort Worth	9,435
Gulf Oil Corp., Sweetwater	8,325
R. Lacy, Inc., Big Sandy	4,000
Magnolia Petroleum Co., Fort Worth	13,320
Premier Oil Refining Co., Arp	5,000
Sid Richardson Refining Co., Texas City	18,000
UTAH	
Sure-Seal Corp., Woods Cross	1,500
WEST VIRGINIA	
Pure Oil Co., Cabin Creek	5,500
WYOMING	
Petroleum Operators Corp., Badger Basin	1,000
Total	221,460

SUMMARY OF REFINERIES IN MEXICO

(Capacity, bbl. per day)

	No. plants	Crude oil	Cracking
Distrito Federal	1	52,000	14,500
Guanajuato	1	30,000	5,000
Tamaulipas	3	118,000	12,500
Veracruz	3	43,500	
Total	8	243,500	32,000

Report on Canadian Operating Refineries

Journal Survey of Refineries in Canada—Their Distribution and Capacity

(Capacity, barrels per stream day)

	No. plants	Crude oil	Vacuum dist.	Thermal operations	Catalytic cracking	Catalytic reforming	Hydro-genation	Alky.	Poly.	Lubes	Coke (tons)	Asphalt
Alberta	10	80,162	4,900	26,500	17,112	1,200		666	1,510		120	9,065
British Columbia	4	68,000	9,500	4,500	22,150				1,300			1,840
Manitoba	4	21,820		3,475	4,550				50			244
New Brunswick	1	300										
N.W. Territory	1	1,388										
Nova Scotia	1	19,980		11,100					4,440			1,034
Ontario	6	159,730	13,500	58,120	59,823	10,830	666		2,460	5,660	266	4,182
Quebec	4	190,060	31,000	46,084	81,315				8,214	490		10,059
Saskatchewan	8	67,300	12,000	22,355	26,596				1,450		100	4,575
Total	39	608,740	70,900	172,134	211,540	12,030	666	666	19,424	6,150	486	30,999

ALBERTA

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
Anglo-American Exploration, Ltd.:									
Hartell	3,000		C 1,500				C 60		
Bonnyville Oil Refineries:									
Bonneville	1,000								
British American Oil Co., Ltd.:									
Calgary	7,200	2,500	C 2,500						S 600
Edmonton	7,000		C 1,400 D-Ck 2,100	F 4,000				C 60	
Excelsior Refineries, Ltd.:									
Lloydminster	2,500	1,000							S 1,200 O 1,200
Husky Oil & Refining, Ltd.:									
Lloydminster	10,000	1,400			Cy 1,200		C 1,200		S 3,500 O 1,000 M 500
Imperial Oil, Ltd.:									
Calgary	10,212		C 5,100			S 666			O 1,065
Edmonton	27,750		C 9,900	F 9,112					
McColl-Frontenac Oil Co., Ltd.:									
Edmonton	8,500		D-Ck 2,200	F 4,000			C 250	C 60	
Wainwright Producers & Refiners, Ltd.:									
Wainwright	3,000		V 1,800						
Total	80,162	4,900	26,500	17,112	1,200	666	1,510	120	9,065

BRITISH COLUMBIA

Imperial Oil, Ltd.:									
Ioco	25,000			F 8,325					O-M 590
Royalite Products, Ltd.:									
Kamloops	5,000	2,500		F 1,425			C 100		S 700
Shell Oil Co. of Canada, Ltd.:									
North Burnaby	27,000	7,000	V 3,000 R 1,500	F 8,700			C 400		S 550
Standard Oil Co. of B. C., Ltd.:									
North Burnaby	11,000			F 3,700			800		
Total	68,000	9,500	4,500	22,150			1,300		1,840

MANITOBA

Anglo-Canadian Oils, Ltd.:									
Brandon	3,000		C 1,375				C 50		
Imperial Oil, Ltd.:									
Winnipeg	13,320			F 4,550					S 244
North Star Oil, Ltd.:									
St. Boniface	5,000		R 1,100 D-Ck 1,000						
Radio Oil Refineries, Ltd.:									
East Kildonan	500								
Total	21,820		3,475	4,550			50		244

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Suppose your specifications call for 18-inch (O.D.) steel pipe with a minimum wall thickness of .219-inch. But the nearest wall thickness available from your pipe supplier is .250-inch. That 1/32-inch difference would mean almost 15 extra tons of metal in every mile—almost enough metal for an additional 4,000 feet of 6-inch pipe with a wall thickness of .109-inch.

You can keep "ghost pipe" to a minimum by specifying Armco Welded Steel Pipe for all your line pipe needs. With the 132 combinations of diameters and wall thicknesses, it's easy to get exactly the pipe you need. Diameters range from 6 to 36 inches; wall thicknesses from 9/64" to 1/2".

You save too with extra long lengths of Armco Pipe. There are fewer sections to handle and fewer joints to make over a given length of line.

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Armco Welded Steel Pipe

NEW BRUNSWICK

	Charging, bbl. per stream day					Production			
	Crude oil	Vacuum dist.	Thermal operations	Cat. cr.	Cat. ref. and hydrogenation	Alkylation	Poly.	Lubes and coke (t./d.)	Asphalt
New Brunswick Oilfields, Ltd.:									
Weldon	300								

NORTHWEST TERRITORY

Imperial Oil, Ltd.:									
Norman Wells	1,388								

NOVA SCOTIA

Imperial Oil, Ltd.:									
Halifax	19,980		C 11,100				C 4,440		O-M 1,034

ONTARIO

British American Oil Co., Ltd.:									
Clarkson	21,500	6,000	4,500	F 17,400			C 1,260	L 1,220	S 1,500 O 500
Canadian Oil Refineries, Ltd.:									
Corunna	25,000	7,500	C 3,000	F 10,000	Pf 4,000		C 1,200		
Husky Oil & Refining, Ltd. (formerly Riverlake Oils, Ltd.):									
Fort Williams	2,500				Cy 1,200				
Imperial Oil, Ltd.:									
Sarnia	86,580		C 4,440 V 4,440 R 8,880 Ck 28,860	F 21,423	HydF 666			C 266 L 4,440	O-M 2,182
Sun Oil Co.:									
Sarnia	16,650			Ho 11,000	Ho 3,330				
Trinidad Leaseholds (Canada), Ltd.:									
Port Credit	7,500		D-Ck 4,000		Pf 2,300				
Total	159,730	13,500	58,120	59,823	R 10,830 Hyd 666		2,460	L 5,660 C 266	4,182

QUEBEC

British American Oil Co., Ltd.:									
Montreal East	45,000	12,000	C 3,500	F 22,000			C 630	L 490	S 5,000 O 2,000
Imperial Oil, Ltd.:									
Montreal East	51,060		V 11,766 R 4,218	F 18,315			C 4,884		O-M 3,059
McColl-Frontenac Oil Co., Ltd.:									
Montreal East	50,000		C 4,500 V 9,600 R 4,500	F 25,000			C 1,500		
Shell Oil Co. of Canada, Ltd.:									
Montreal East	44,000	19,000	C-V-R 8,000	F 16,000			C 1,200		
Total	190,060	31,000	46,084	81,315			8,214	490	10,059

SASKATCHEWAN

British American Oil Co., Ltd.:									
Moose Jaw	15,000	5,500	C 1,500 D-Ck 2,250	F 10,000			C 390	C 100	S 1,200
Consumers Co-Operative Refineries, Ltd.:									
Regina	12,000	6,500	V 3,000	F 5,000			C 500		
Husky Oil & Refining, Ltd. (formerly Moose Jaw Refineries, Ltd.):									
Moose Jaw	2,000								S 1,000
Imperial Oil, Ltd.:									
Regina	25,000		C 8,325 R 3,440	F 8,990			C 300		O-M 325
Northern Petroleum Corp., Ltd.:									
Kamsack	800								
Prince Albert Refineries, Ltd.:									
Prince Albert	1,000								S 150
Royalite Products, Ltd.:									
Coleville	5,000								S 1,300
Royalite-Hi-Way, Ltd.:									
Saskatoon	6,500		V 3,840	F 2,600			C 260		S 600
Total	67,300	12,000	22,355	26,590			1,450	100	4,575

ALBATROS

Now on-stream at Antwerp, Belgium is the newest

HOUDRIFLOW

catalytic cracking unit in Europe. This Albatros S. A. Belge pour le Raffinage de Petrole cracker is designed for a capacity of 3600 BPSD. It is a moving bed, gas-lift design, and the eighty-fifth Houdry licensed catalytic unit.

HOUDRY

PROCESS CORPORATION

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International Representative: World Commerce Corporation, S.A.

PIONEER IN CATALYTIC PROCESSES

SHAMROCK

A world's record for all types of catalytic cracking units has been set by the

HOUDRIFLOW

unit of the Shamrock Oil and Gas Corporation at Sunray, Texas. Going on stream in 1951, this cracker has achieved unit operation above 90% conversion at greater than design thruput and with high efficiency.

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PIONEER IN CATALYTIC PROCESSES

PETROCARBON

Petrocarbon Chemicals, Inc. is operating a

HOUDRIFORMER

at its Irving plant located near Dallas, Texas. The new catalytic unit has a capacity of 1000 BPSD. It has been designed for a high degree of flexibility in petro-chemical service and in processing high octane fuels.

HOUDRY

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PIONEER IN CATALYTIC PROCESSES

CROWN

Crown Central Petroleum Corporation is installing a new

HOUDRIFORMER

at its refinery near Houston, Texas. Rated at 5000 BPSD, the new unit will handle typical stocks processed in gulf coast refineries. Although designed primarily for up-grading motor gasoline, it will also produce aromatics and aviation blended stocks.

HOUDRY

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PIONEER IN CATALYTIC PROCESSES

TCR

TEXAS CITY REFINING, INC.

Texas City Refining, Inc. went on-stream with a new

HOUDRIFLOW

Catalytic Cracking Unit in August, 1953 at Texas City, Texas. This modern, 19,000 BPSD Houdriflow cracker is operating at conversion levels from 60% to over 80%.

HOUDRY

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PIONEER IN CATALYTIC PROCESSES

DAIKYO OIL JAPAN

The Daikyo Oil Company goes on stream this year with a new

HOUDRIFLOW

Catalytic Cracking Unit. Designed for a gross capacity of 4200BPSD, this new cracker is the first of its kind to be built in the Orient. It is an important part of the modernization and expansion program undertaken by the Japanese refining industry.

HOUDRY

PROCESS CORPORATION

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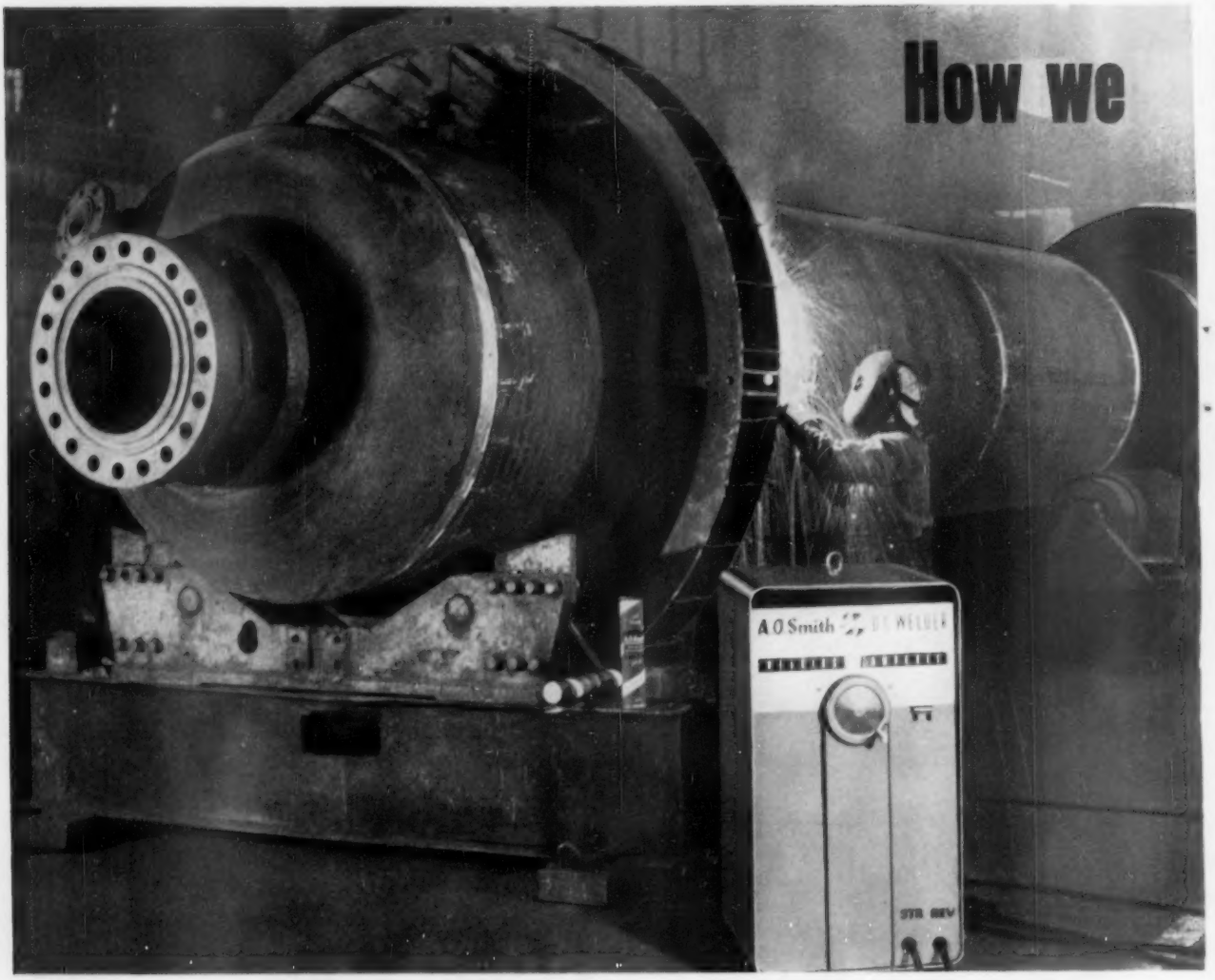
PIONEER IN CATALYTIC PROCESSES



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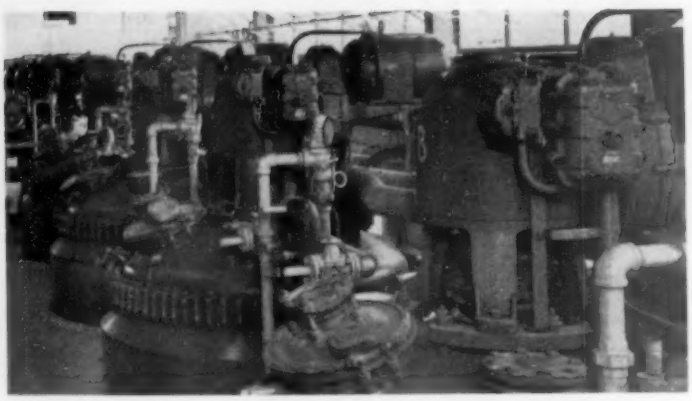
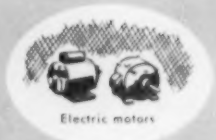
Glass-lined processing equipment for corrosive service in the petroleum industry is available from Glascote Products, Inc., subsidiary of A. O. Smith. With a long and successful background in the design and production of corrosion-resistant vessels and accessories, Glascote can fill your needs for laboratory and pilot plant reactors...single-shell or jacketed tanks . . . double-jacketed condensers . . . columns.



Get all the facts by writing for your free copy of "OIL", a booklet describing our products for the petroleum industry.



work steel to make steel work for you

A. O. Smith welding equipment is shop-proved for heavy-duty service

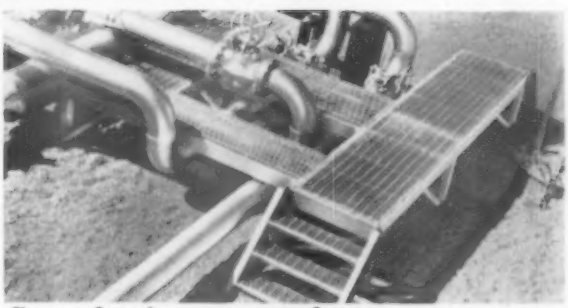
Picture shows one of A. O. Smith's many production shops where welding machines and electrodes are put to work on the most difficult assignments. Here a DC Rectifier helps build a stainless-steel-lined platform tower for a western refinery.

A leading supplier of all types of vessels and exchangers for the petroleum industry, A. O. Smith also ranks as a pioneer in the modern development of welding. During World War I, we originated the first successful shielded arc-welding electrode, and through a continuous program of research, we have since made many similar important contributions to the progress of welding science.

It makes good business sense to depend on A. O. Smith for welded refinery vessels . . . *and for welding equipment.*

It must be "OK"...

To pass final inspection this vertical hollow shaft pump motor must perfectly match the operating characteristics of the vertical turbine pump it is designed to power. We also application-engineer integral and fractional hp motors for other uses in the petroleum industry. Let us know *your* needs.



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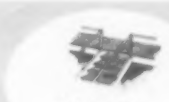


With the building of new refineries, the replacing of old units, and the adding of new processes, construction in refining should maintain a high rate through the remainder of the year.

U.S. Refiners Building 2 Million Barrels Capacity

by John M. McGivern

UNITED STATES and Canadian refiners are building at a 21.4 per cent greater rate than in March 1954.

The 1955 Journal construction survey shows approximately 2,075,000 bbl. of charge and production capacity under way or slated to be started shortly.

Last March, refiners here and in Canada were building or planning 1,700,000 bbl. Some of the jobs shown for 1955 were started in 1954. However, many of the projects listed in the 1954 survey were begun in 1953, thus a legitimate comparison can be made.

Two major refineries will wind up construction this August and begin operations. While Shell Oil Co.'s 50,000-bbl. plant at Anacortes, Wash., will go on stream in August, some of the catalytic units are due to lag behind until October. At Pinde Bend, Minn., Great Northern will fire its 25,000-bbl. plant, also in August.

However, new construction starts will far outweigh completions. Tide Water Associated Oil Co.'s 130,000-bbl. giant at Delaware City, Del., leads the newcomers.

American Oil Co. has awarded the initial contracts for work on its 35,000-bbl. refinery at Yorktown, Va. Both Tide Water and Amoco plan to begin operations in 1956.

Pontiac Eastern Corp. and Miami Oil & Refining Co. have announced plans for southern refineries. Pontiac Eastern, a subsidiary of Pontiac Refining Corp., Corpus Christi, Tex., is looking for a site in Mississippi. When it's found, the company will begin work on a 12,000-bbl., $10,000,000 refinery.

Miami Oil, headed by M. H. Robineau, president of Frontier Refining Co., of Denver, has received a tax writeoff for $12,000,000 for a 15,000-bbl. operation at West Palm Beach, Fla.

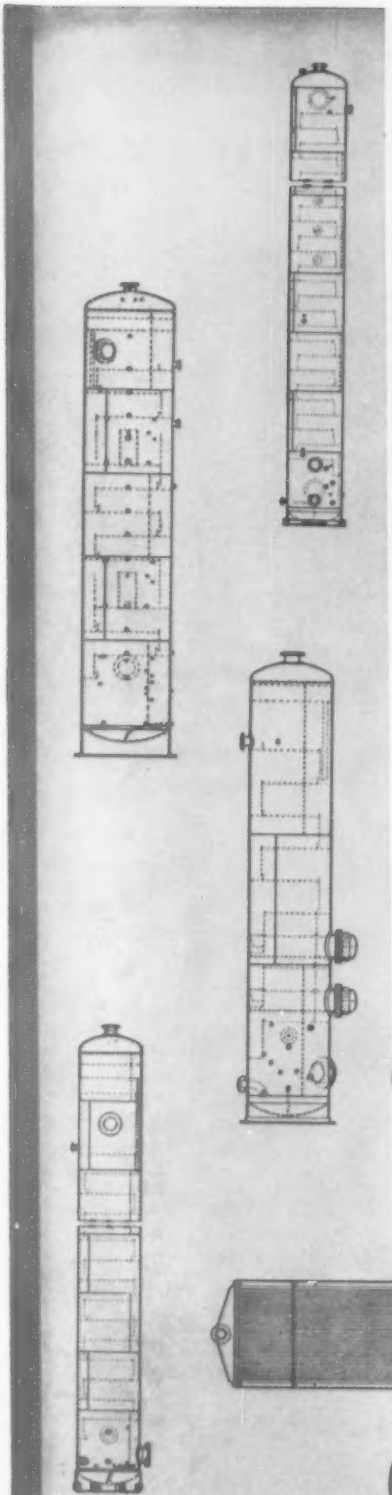
Hawaii may have a wait until it attains statehood; however, Standard Oil Co. of California's plans may make the Pacific island a minor refining center this year. The company has given no definite date but has indicated it will erect a 20,000 to 30,000-bbl. refinery near Honolulu soon.

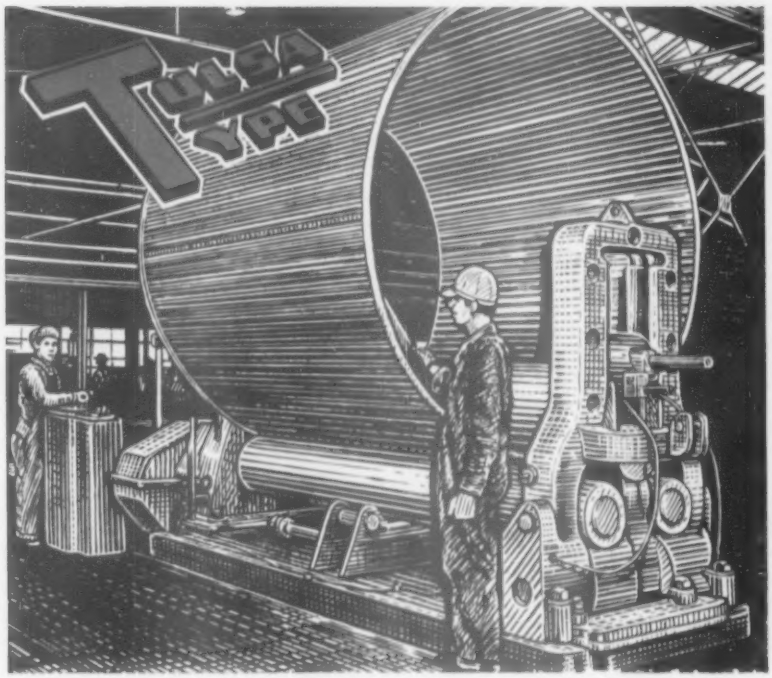
Puerto Rico, the little island possession in the Antilles, will be host to two refineries by the end of 1955. Caribbean Refining Co. will go on stream with its 10,500-bbl. refinery at Bayamon May 1. Commonwealth Oil Refining Co., Inc., will have its 23,500-bbl. plant at Guayanilla Bay ready during the last quarter of the year.

A rash of planned refineries for the Albuquerque, N. M., and Phoenix, Ariz., areas has been temporarily stopped. Standard Oil Co. of Texas made an Albuquerque project less appealing by entering the area with a products line from El Paso. Southern Pacific Railway made the promoters at Phoenix look at their hole cards when it announced lines from Los Angeles and El Paso to serve the area.

Great Plains Oil & Development Co. has awarded contracts for a 5,000-bbl. plant at Rapid City, S. D. Sunset Oil Co. has indicated that it is looking toward Portland, Ore., as a site for a 20,000-bbl. refinery, and Supertest Petroleum Corp. has announced plans for a plant in southern Ontario. Avtane Refining Co. announced plans for a high-octane operation at Freeport, Tex., last summer; however, nothing further has been announced since.

Gulf Oil Corp. and Standard Oil Co. (Ind.) have announced multimillion dollar programs to add crude capacity to replace old, obsolete units. Cat reforming has not reached its saturation point, and hydrogenation is still in the infant stage.





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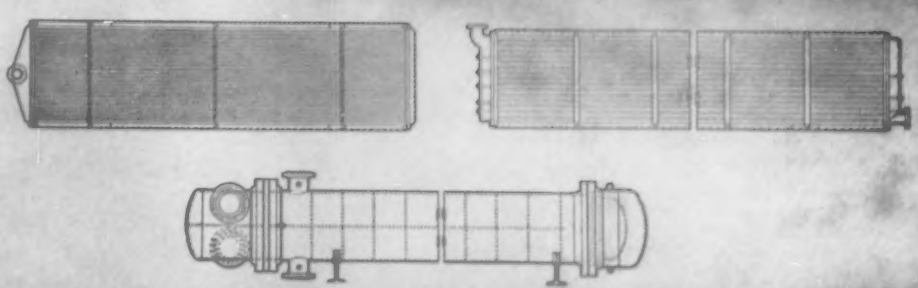


PLATE FABRICATING_____STRUCTURAL FABRICATING
REINFORCING FABRICATING_____WAREHOUSE PRODUCTS

What and Where They're Building

Active refinery-construction projects as reported to the Journal

A

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
American Oil Co., Yorktown, Va.:		
Building new refinery	35,000	1956
Model B Orthoflow, Kellogg design	30,000	1956
Polymerization unit	800	1956
Other units not announced yet		1956
Anderson-Prichard Oil Corp., Cyril, Okla.:		
Adding to present poly unit	80	1955
Anglo-American Exploration, Ltd., Hartell, Alta.:		
Adding atmospheric distillation capacity	1,000	7- 1-55
Planning Catformer	1,000	1955
Arizona Refining Co., Coolidge, Ariz.:		
Planning new refinery	25,000	
Ashland Oil & Refining Co., Buffalo:		
Planning reforming unit. Type not determined	4,000	4- 1-56
Planning catalytic hydrogenation unit. Type not determined	5,000	4- 1-56
Ashland Oil & Refining Co., Catlettsburg, Ky.:		
Adding to crude unit	16,000	4- 1-56
Planning cat cracker. Type undetermined	32,000	4- 1-56
Building Houdriformer	6,000	6- 1-55
Adding Hydrodesulfurizer	8,500	6- 1-55
Ashland Oil & Refining Co., Findlay, Ohio:		
Planning reforming unit. Type undetermined	3,000	4- 1-56
Planning catalytic hydrogenation unit. Type undetermined	4,000	4- 1-56
Aurora Gasoline Co., Detroit:		
Building fluid coking unit	4,000	Late 1955
Adding to present fluid cat cracker	1,500	Fall 1955
Building Unifiner	7,500	Late 1955
Adding to catalytic polymerization unit	250	5- 1-55
Production from coker (tons)	100	Late 1955
Avtane Refining Co., Freeport, Tex.:		
Has tax write-off for new refinery	10,000	

B

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Berry Asphalt Co., Waterloo, Ark.:		
Increasing asphalt capacity	600	1955
British American Oil Co., Ltd., Montreal East:		
Adding Catformer	13,000	Late 1955

C

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Caribbean Refining Co., Bayamon, Puerto Rico:		
Building new refinery	10,500	5- 1-55
Vacuum unit	6,800	5- 1-55
Fluid catalytic cracking unit	5,000	5- 1-55
Catalytic poly unit	500	5- 1-55
Century Refining Co., Inc., Shallow Water, Kans.:		
Planning Platforming unit	1,000	1955
Adding oxidized asphalt capacity	600	1955
Champlin Refining Co., Enid, Okla.:		
Adding to crude capacity	8,000	1956
Increasing vacuum unit	4,000	1956
Building Orthoflow catalytic cracker	9,000	Late 1955
Building Platformer	5,000	5- 1-55
Adding catalytic polymerization	1,200	Late 1955
Col-Tex Refining Co., Colorado City, Tex.:		
Adding to polymerization unit	80	1955
Commonwealth Oil Refining Co., Inc., Guayanilla Bay, Puerto Rico:		
Building new refinery	23,500	Late 1955
Vacuum unit	17,000	Late 1955
Houdriflow cat cracker	26,800	Late 1955
Houdriforming unit	3,700	Late 1955
Alkylation unit, sulfuric acid type	1,400	Late 1955
Catalytic poly unit	900	Late 1955
Cosden Petroleum Corp., Big Spring, Tex.:		
Adding to crude unit	2,000	4- 1-55
Increasing vacuum distillation	3,000	4- 1-55
Adding to fluid cat cracker	3,000	Fall 1955
Planning second reformer unit. Type undecided	3,200	9- 1-55

E

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Eastern States Petroleum Co., Inc., Houston:		
Increasing Unifiner	7,000	4- 1-55
El Dorado Refining Co., El Dorado, Kans.:		
Increasing crude unit	2,500	4- 1-55
Adding to vacuum unit	2,000	4- 1-55
Boosting fluid cat cracking capacity	1,200	4- 1-55
Adding to poly unit	100	4- 1-55
Increasing asphalt capacity	300	4- 1-55
Elk Refining Co., Falling Rock, W. Va.:		
Building Unifining hydrogenation unit	1,500	5- 1-55
Esso Standard Oil Co., Everett, Mass.:		
Adding to asphalt capacity	2,600	5- 1-55
Esso Standard Oil Co., Linden, N. J.:		
Completing addition to fluid cat cracker	20,000	3-31-55
Esso Standard Oil Co., Baltimore:		
Building fluid coker	10,000	6- 1-55
Adding to fluid catalytic cracking unit	24,000	6- 1-55
Building Hydroforming unit	3,000	6- 1-55
Completing two Hydrofining units (combined capacity)	17,000	6- 1-55
Adding to sulfuric alkylation	415	6- 1-55
Production from coker (tons)	140	6- 1-55

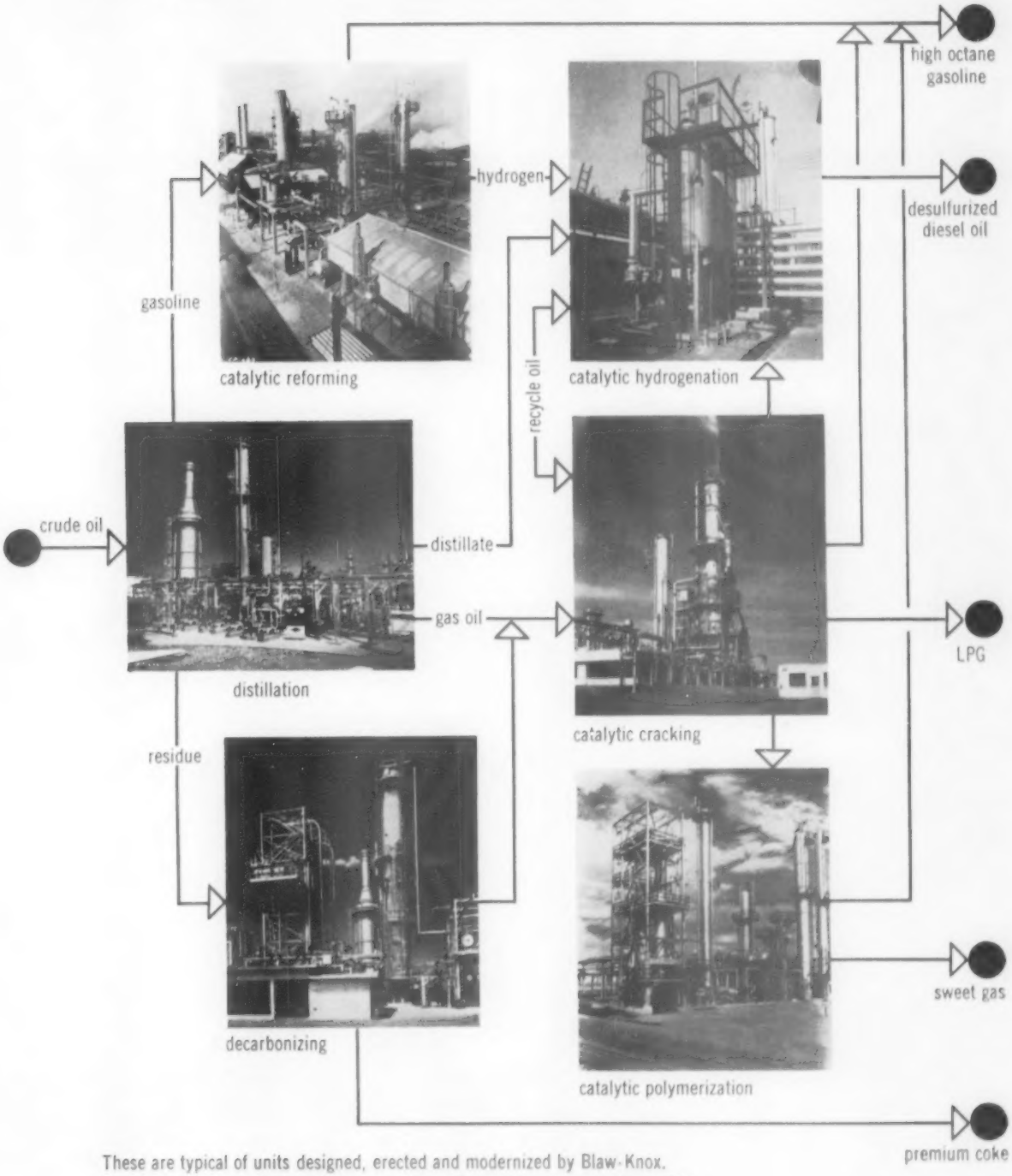
F

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Famariss Oil & Refining Co., Monument, N. M.:		
Building a Platformer	650	Spring '55
Fletcher Oil Co., Wilmington, Calif.:		
Building a crude unit	10,000	7- 1-55
Four States-Western Oil Refining Co., Farmington, N. M.:		
Announced plans for a new refinery	2,000	
Frontier Refining Co., Cheyenne, Wyo.:		
Adding to present crude unit	2,500	8- 1-55
Building Platformer	2,000	8- 1-55
Installing Unifiner	3,000	8- 1-55

G

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Great Northern Oil Co., Pine Bend, Minn.:		
Building new refinery	25,000	8- 1-55
Delayed coker (tons)	450	8- 1-55
Thermofor cat cracker	12,000	8- 1-55
Ultraformer	5,000	8- 1-55
Hydrodesulfurization	11,000	8- 1-55
Catalytic poly.	900	8- 1-55
Great Plains Refinery & Development Co., Rapid City, S. D.:		
Building new refinery	5,000	Early '56
Thermofor cat cracker	3,000	Early '56
Cat poly unit		Early '56
Gulf Oil Corp., Port Arthur, Tex.:		
Adding to crude unit	74,400	1956
Increasing vacuum unit	30,000	1956
Adding to fluid cat cracking capacity	54,000	1956
Building Platformer	30,000	Spring '55
Gulf Refining Co., Cincinnati:		
Building Platformer	10,000	1955
Gulf Refining Co., Toledo:		
Building Platformer	10,000	1955

BLAW-KNOX Catalytic Processing for Maximum Profits



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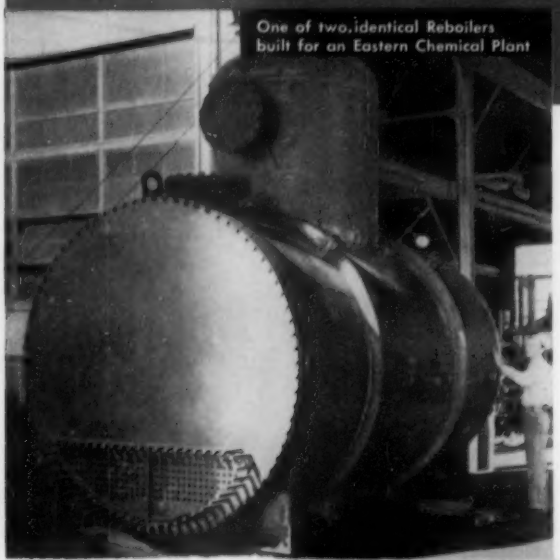
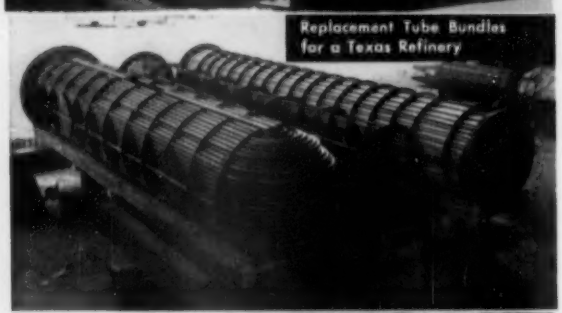
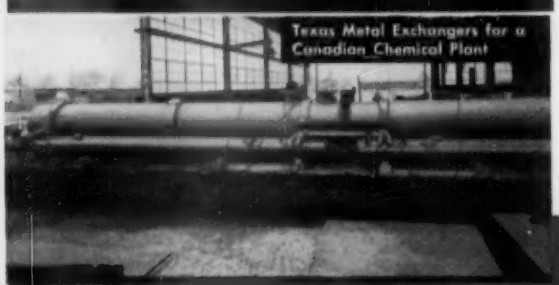


One of two identical Reboilers built for an Eastern Chemical Plant



Replacement Tube Bundles for a Texas Refinery



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H

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Humble Oil & Refining Co., Baytown, Tex.:		
Adding Ultraformer	20,000	6- 1-55
Converting fixed bed Hydroformer to Ultraformer	20,000	7- 1-55
Hunt Oil Co., Tuscaloosa, Ala.:		
Increasing crude unit	800	9- 1-55
Husky Oil & Refining, Ltd., Fort Williams, Ont.:		
Increasing crude-oil capacity	3,200	7- 1-55
Platformer	.....	7- 1-55
Diesulformer	.....	7- 1-55
Asphalt plant	.....	7- 1-55
Husky Oil & Refining, Ltd., Moose Jaw, Sask.:		
Increasing crude-oil capacity	3,000	7- 1-55
Catformer	.....	7- 1-55
Diesulformer	.....	7- 1-55
Vacuum unit and visbreaker	.....	7- 1-55

I

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Imperial Oil, Ltd., Edmonton:		
Adding lube-oil capacity	2,000	7- 1-55
Imperial Oil, Ltd., Ioco, B. C.:		
Adding a naphtha fractionator		9- 1-55
Building a cat poly unit	2,340	9- 1-55
Imperial Oil, Ltd., Halifax, N. S.:		
Adding atmospheric and vacuum distillation unit	45,000	Spring '56
Building a fluid cat cracker	16,900	Spring '56
Imperial Oil, Ltd., Montreal East:		
Adding new atmospheric and vacuum unit	15,000	Spring '55

L

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Lakeside Refining Co., Kalamazoo, Mich.:		
Building visbreaking unit	1,500	1955
Leonard Refineries, Inc., Alma, Mich.:		
Increasing crude capacity	3,500	1955
Planning a reforming unit, either Platformer, Houdriformer, or Ultraformer	3,600	1955
Building a Unifiner	4,200	1955

M

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Magnolia Petroleum Co., Beaumont, Tex.:		
Planning to increase crude unit	15,000	1958
Increasing vacuum unit	35,200	1957
Planning to increase Thermofor cat capacity	35,800	1957
Thermofor reformer	19,500	1955
Sovaformer	11,000	1958
Sovaformer	6,700	1959
Sovafining	30,000	1956
McColl-Frontenac Oil Co., Ltd., Montreal East:		
Building Platformer	12,000	6- 1-55
McColl-Frontenac Oil Co., Ltd., Edmonton:		
Adding to crude unit	2,500	6- 1-55
Building gas-oil cracking capacity	3,000	6- 1-55
McMurrey Refining Co., Tyler, Tex.:		
Building sulfuric alkylation unit	1,300	Fall 1955
Mid-Continent Petroleum Corp., Tulsa:		
Building delayed-coking unit	7,000	11- 1-55
Adding to fluid cat cracker	3,500	9- 1-55
Production from coker (tons)	240	11- 1-55

N

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Navajo Refining Co., Albuquerque, N. M.:		
Planning new refinery	10,000	
New Mexico Asphalt & Refining Co., Artesia, N. M.:		
Adding to crude unit	2,500	1955
North Star Oil, Ltd., St. Boniface, Man.:		
Building new refinery, junking old one	12,000	7- 1-55
Vacuum unit	5,000	7- 1-55
Fluid Model B Kellogg cat cracker	5,200	7- 1-55
Thermal poly unit	423	7- 1-55
Northwestern Refining Co., St. Paul Park, Minn.:		
Adding to crude unit	5,000	9- 1-55
Building thermal poly unit	500	4- 1-55

O

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Osceola Refining Co., Inc., Reed City, Mich.:		
Building Catformer	500	7- 1-55

P

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Pacific Oil & Refining Co., Tacoma, Wash.:		
Company will build refinery under a new company name	10,000	
Pennzoil Co., Rouseville, Pa.:		
Considering Platformer and Unifiner	.....	.....
Phillips Petroleum Co., Phillips, Tex.:		
Adding Platformer	16,000	1955
Phoenix Refining Co., Phoenix:		
Planning new refinery	15,000	.....
Pontiac Eastern Corp., South Central Mississippi:		
Planning new refinery	12,000	.....
Pure Oil Co., Toledo:		
Increasing crude unit	10,000	1st Q '55

R

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
R&J Oil & Refining Co., Princeton, Ind.:		
Adding to crude unit	4,200	5- 1-55
Building gas-oil cracking unit	1,500	5- 1-55
Planning thermal poly unit	.....	1955
Royalite Products, Ltd., Coleville, Sask.:		
Adding vacuum unit	3,850	7- 1-55
Increasing asphalt capacity	2,500	7- 1-55

S

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Salt Lake Refining Co., Salt Lake City:		
Adding fluid cat cracker	8,000	5- 1-55
Shell Oil Co., Anacortes, Wash.:		
Building new refinery	50,000	8- 1-55
Vacuum unit	19,000	10- 1-55
Fluid cat cracker	22,000	10- 1-55
Platformer	8,000	8- 1-55
Hydrodesulfurization	8,000	8- 1-55
Catalytic poly	3,800	10- 1-55
Sinclair Refining Co., East Chicago, Ind.:		
Building Sinclair-Baker reforming unit	17,000	4- 1-55
Sioux Oil Co., Newcastle, Wyo.:		
Adding to crude unit	2,000	Late 1955
Adding gas-oil cracking unit	1,000	Late 1955
Adding to cat poly unit	75	Late 1955
Socony-Vacuum Oil Co., Inc., Buffalo:		
Gasoline treating unit		9- 1-55
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:		
Sovaformer	20,000	11- 1-55
Socony-Vacuum Oil Co., Inc., Trenton, Mich.:		
Sovaformer	9,000	12- 1-55
Socony-Vacuum Oil Co., Inc., East Chicago, Ind.:		
Sovaformer	9,000	12- 1-55
Catalytic poly unit	.....	12- 1-55
Company also has future plans for Sovaformers at East St. Louis, Casper, Buffalo, and Brooklyn.		
Standard Oil Co. of California, El Segundo, Calif.:		
Building Platformer	22,200	Spring '55
Adding Unifiner	22,200	Spring '55
Standard Oil Co. of Calif., Richmond, Calif.:		
Building Platformer	22,200	Spring '55
Adding Unifiner	22,200	Spring '55
Standard Oil Co. of Calif., Honolulu, Hawaii:		
Planning new refinery	20-30,000	

Company, location of refinery, and type of project—	Capacity or prod. rating (bbl. per stream day)	Completion schedule
Standard Oil Co. (Ind.), Whiting, Ind.:		
New crude unit. Company will retire some old units	60,000	Early '56
New vacuum unit. Company will retire some old units	22,800	Early '56
Standard Oil Co. (Ind.), Wood River, Ill.:		
Planning continuous coker	9,500	1957
Building Houdriformer	9,000	Spring '55
Production from coker (tons)	330	1957
Standard Oil Co. (Ind.), Sugar Creek, Mo.:		
Building Ultraformer	14,000	Late 1955
Standard Oil Co. (Ind.), Mandan, N. D.:		
Planning Ultraformer	3,750	1956
Standard Oil Co. of Ohio, Lima, Ohio:		
Adding to cat poly unit	200	Summer '55
Standard Oil Co. of Texas, El Paso:		
Building Platformer	4,300	7- 1-55
Sun Oil Co., Marcus Hook, Pa.:		
Building a Houdriflow cat cracker	26,000	5- 1-55
Adding a Houdriformer	18,000	5- 1-55
Sun Oil Co., Toledo:		
Adding a Houdriflow cat cracker	26,000	5- 1-55
Suntide Refining Co., Corpus Christi, Tex.:		
Adding to crude unit	10,000	5- 1-55
T		
Texas City Refining, Inc., Texas City, Tex.:		
Planning a reforming unit. Type undecided	6,000	1955
The Texas Co., Port Arthur, Tex.:		
Building Platformer	20,000	7- 1-55
The Texas Co., Tulsa:		
Building Platformer	9,000	9- 1-55
The Texas Co., Lockport, Ill.:		
Building Platformer	11,000	9- 1-55
Adding to sulfuric alkylation unit	1,200	7- 1-55
The Texas Co., Lawrenceville, Ill.:		
Building Platformer	13,500	7- 1-55
Adding sulfuric alkylation unit	2,000	7- 1-55
The Texas Co., Wilmington, Calif.:		
Building Platformer	10,000	7- 1-55
Tide Water Associated Oil Co., Delaware City, Del.:		
Building new refinery	130,000	Late 1956
Orthoflow cat cracker	102,000	Late 1956
Fluid coker	42,000	Late 1956
Houdriformer		Late 1956
Hydrodesulfurization		Late 1956
Catalytic poly unit		Late 1956
Alkylation unit		Late 1956
Sulfur recovery plant		Late 1956
Trinidad Leaseholds (Canada), Ltd., Port Credit, Ont.:		
Revamping crude unit. Adding	6,500	12- 1-55
U		
Union Oil Co. of California, Oleum:		
Building a Unisol unit	5,000	1955
Hydrogen sulfide recovery plant		1955
Sulfur plant		1955
Union Oil Co. of California, Santa Maria, Calif.:		
Adding a coking unit	18,700	1955
Sulfur plant (tons)	42	1955
Union Oil Co. of California, Los Angeles:		
Building enriched crude-oil handling unit		1955
V		
Vickers Petroleum Co., Inc., Potwin, Kans.:		
Considering reforming units, increasing cat poly unit, asphalt capacity, and coking unit		
W		
Williston Basin Refining Corp., Williston, N. D.:		
Building gas-oil cracking unit	1,000	7- 1-55
Wisconsin Oil Refining Co., Inc., Sheboygan, Wis.:		
Building vacuum unit	1,000	1955

BOOKS

MODERN PETROLEUM TECHNOLOGY, Second Edition. Edited by E. B. Evans. Published by the Institute of Petroleum, 26 Portland Place, London, England. 702 pp., $4.90 post free.

Some of England's leading petroleum scientists have collaborated in the writing of this second edition of a comprehensive text on the fundamentals of modern oil technology. Subjects covered, by sections, include: (1) exploration and production; (2) the nature of petroleum; (3) manufacture and refining of petroleum products; (4) properties and utilization of petroleum products; (5) tests and their significance; (6) transportation and distribution; and (7) the economic aspects of the petroleum industry.

In short, here's a capsule description of modern petroleum technology—simply written, fully illustrated, and highly authoritative. It's a worthy successor to a first edition that has been one of the basic oil-technology texts since its publication in 1946.

CAPITAL AND OUTPUT TRENDS IN THE MINING INDUSTRIES, 1870-1948. By Israel Borenstein. Published as Occasional Paper No. 45 by the National Bureau of Economic Research, 261 Madison Avenue, New York 16. 81 pp., $1.

One of a series of bureau studies in capital formation and financing, this is an analysis of long-term trends in America's mining industries. It brings out such interesting facts as this—that use of minerals in the United States has lagged behind the growth of national product since World War I. Prior to that time, it had grown steadily since our nation's early days. The author's reason for this: technological change that resulted in savings of material, such as greater use of scrap in making steel. A special value of the book to oil economists and production people is its breakdowns of mineral classifications, which permit easy comparison of petroleum with other minerals.

"Okay, look at it this way, if the boss wasn't dumb, maybe we wouldn't be working here."

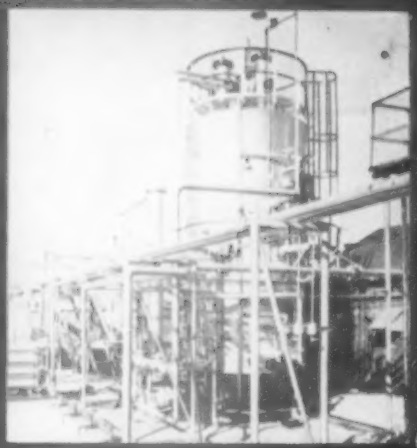
THE OIL RESOURCES OF TEXAS, A RECONNAISSANCE SURVEY OF PRIMARY AND SECONDARY RESERVES OF OIL. By George H. Fancher with Robert L. Whiting and James H. Cretsinger. Published by and available from the Texas Petroleum Research Committee, University of Texas Division, Austin, 358 pages. $5.

"The Oil Resources of Texas" is the result of 4 years of intensive study of the oil reserves of Texas by the Texas Petroleum Research Committee. It is a valuable contribution to the petroleum industry and covers the reserves of Texas and the cumulative production by fields as well as by producing formations.

The book analyzes each Railroad Commission District, giving:

1. History and development of oil production.
2. Maps showing oil fields.
3. Geological sections showing oil reserve and oil production data for the different formations.
4. Oil productive acreage.
5. Original oil in place.
6. Ultimate primary oil reserves.
7. Secondary oil reserves.
8. Production data.

A NEW CONCEPT IN LIGHT OIL REFINING



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Doctor Treating
Water Washing
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Kerosine
Jet fuel
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Continuous
Vapor tight
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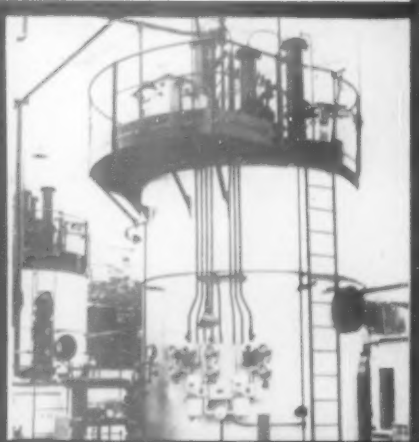
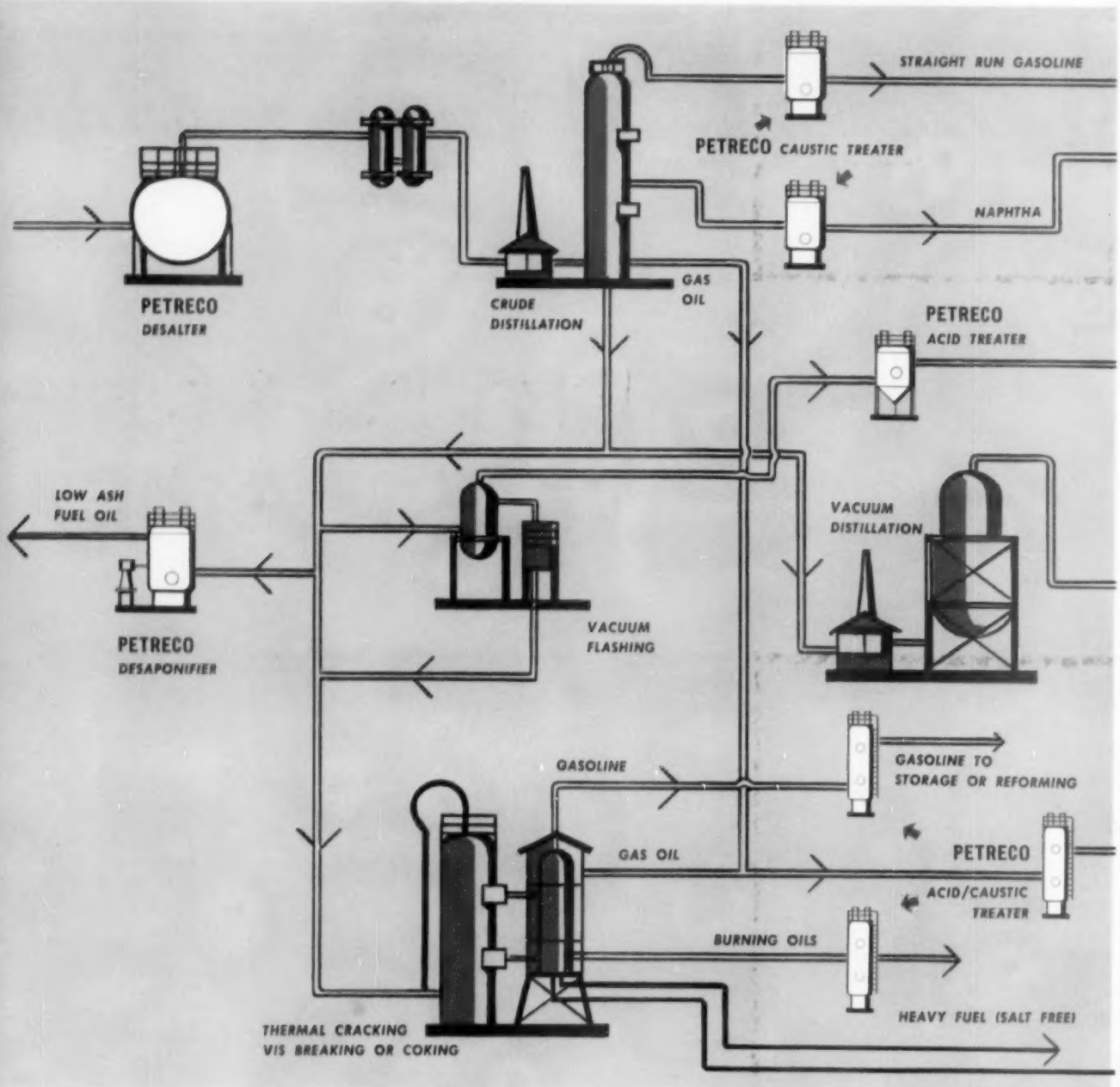
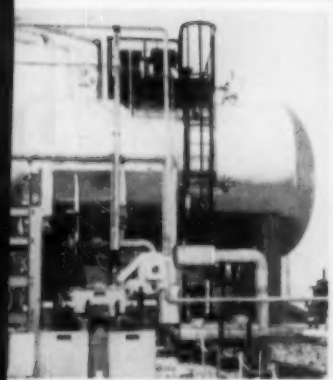
Economical

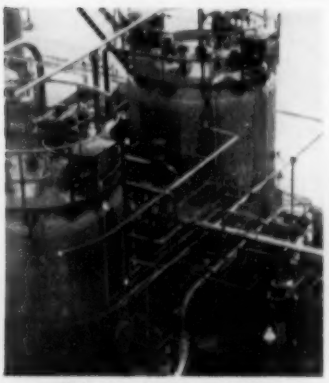


PETRECO *electric processing*





Petreco Desalting



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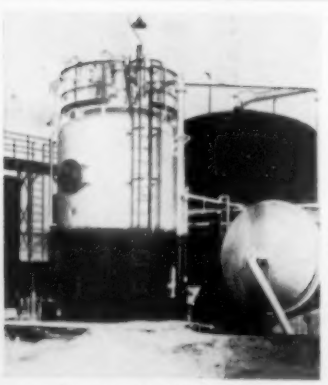
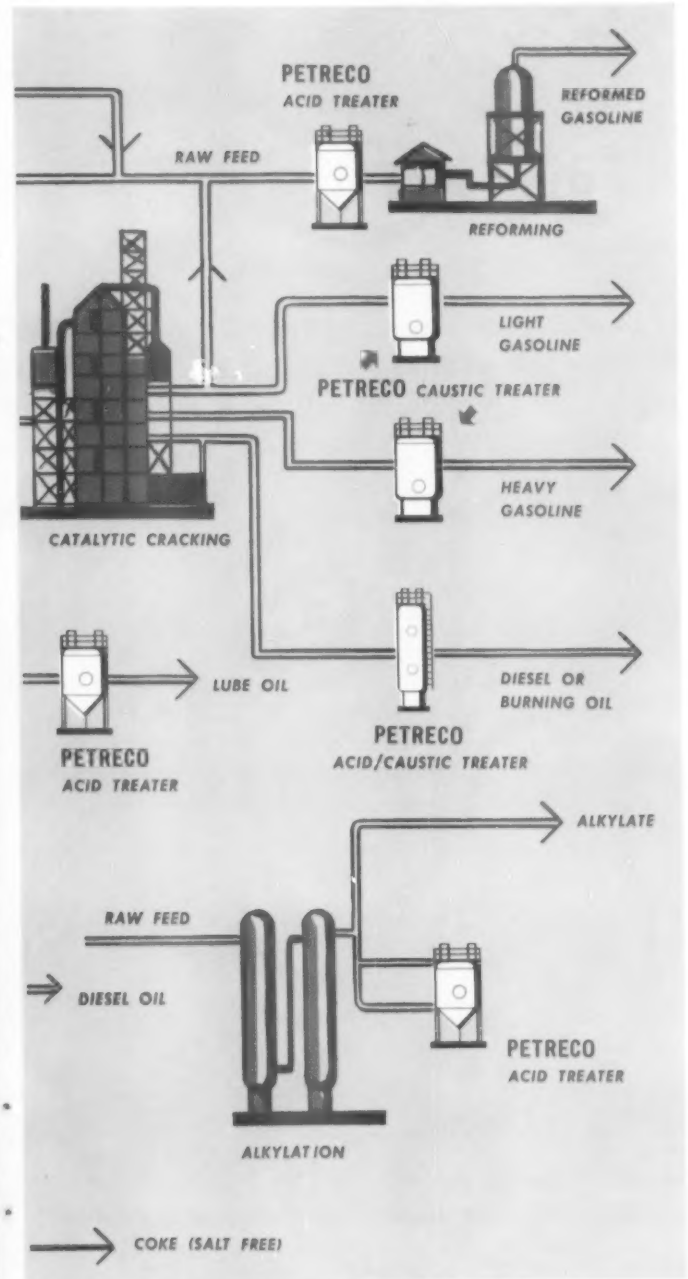


Petreco Acid Treater

Petreco Doctor Treater

is widely applicable in refining



The treating of light petroleum stocks with acid, alkali or other chemicals is, of course, not a new concept in petroleum refining. However, the application of the forces of the electric field, as in Petreco *Electrofining*, is entirely new in this phase of refining. The *Electrofining* process provides a precision-controlled method for continuously contacting a light hydrocarbon stream with a treating agent, then separating the chemical phase from the treated product.

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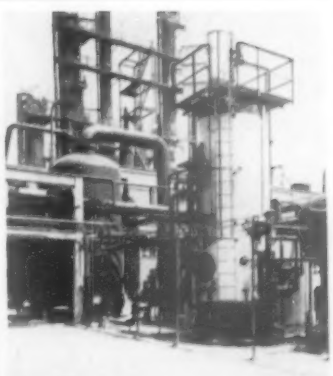

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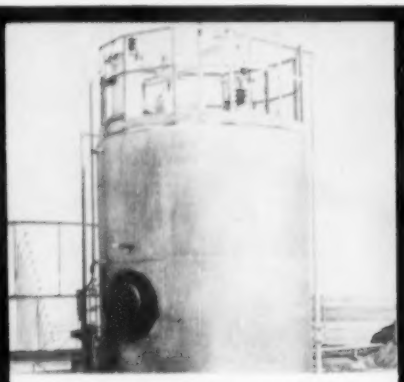

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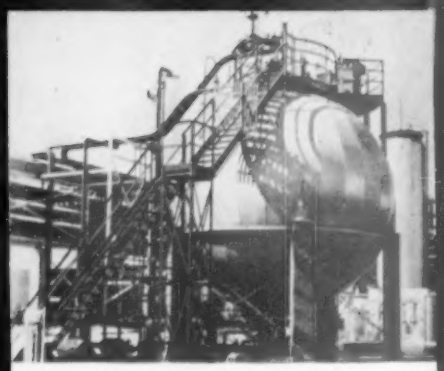

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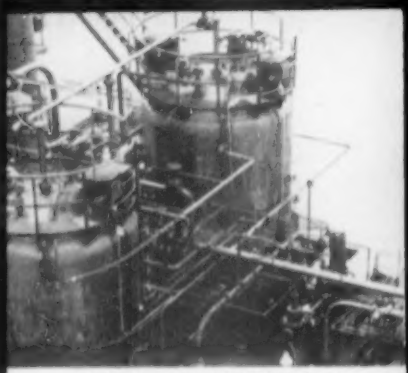

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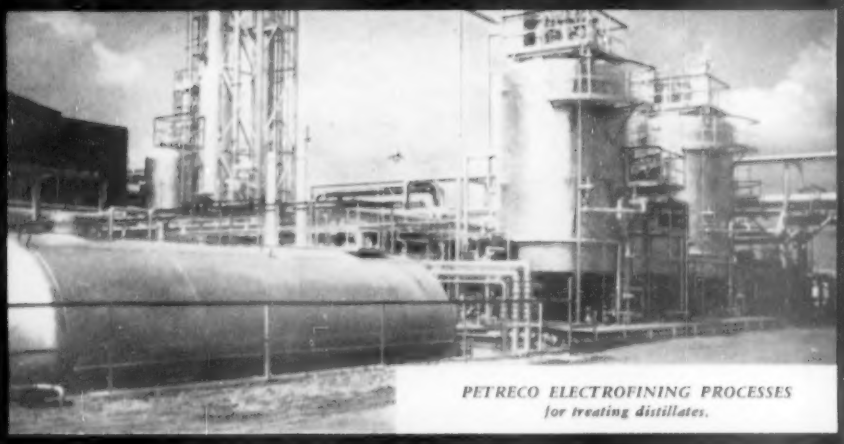

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WEST TEXAS DRILLING . . . 2 YEARS LATER

Year	Field—	Intermediate hole— Size (in.)	No. bits	Days	Production hole— Size (in.)	No. bits	Days	Total— Bits	Days	Depth, ft.
1952	Townsend	11	20	22	7⅞	98	81	118	103	10,581
1954	Townsend	11	8	12	7⅞	60	37	68	49	10,629
1952	Denton	11	14	14	7⅞	120	84	135	98	12,229
1954	Denton	11	11	11	7⅞	81	57	70	68	12,472
1952	Yarbrough Allen	12¼	6	8	8¾	71	59	77	67	10,719
1954	Yarbrough Allen	12¼	8	10	8¾	69	53	61	63	10,575
1953	Magutex	12¼	14	14	8¾	65	72	79	86	12,570
1954	Magutex	12¼	8	13	8¾	62	62	70	75	12,607
1953	Midland Farms	12¼	16	13	8¾	102	77	118	90	12,654
1954	Midland Farms	12¼	11	12	8¾	63	44	74	56	12,490

Why Permian Basin Drilling Times Are Better

Equipment is deing matched to the job with greater care, new practices and techniques employed, and new approaches to old problems tried and analyzed

by R. J. Bromell

DRILLING times in the Permian basin today are much better than 2 years ago. The reason for this is a more scientific approach to drilling problems and closer cooperation between contractors and operators.

Weight on bit has gone up, bringing faster drilling. It also has brought more crooked-hole troubles, a need for more drill collars, and greater power to handle the loads. The added power for hoisting has often been applied to jet drilling. This also speeded drilling. There are still questions about the size of pump needed and the proper use of jet bits; but it appears that pumps in the 200 to 500-hp. class will be best in this area.

Bit weights have increased greatly in the Permian basin during the past 2 years. Normal practice of carrying 30,000 to 40,000 lb. on 12¼-in. bits has now increased to 70,000 to 110,000 lb. Now, 8¾-in. bits carry 50,000 to 80,000 lb. instead of the 30,000 to 45,000 lb. of 2 years ago.

Some contractors are even carrying 70,000 lb. on 7⅞-in. bits and 50,000 lb. on 6¾-in. bits. This is not yet a general practice. Average weights in 7⅞-in. hole are from 35,000 to 50,000 lb.; and in 6¾-in. hole, 30,000 to 35,000 lb.

Jet bits brought the higher weight on the 12¼-in. bits. Without jet bits, much of the benefit of high weight in the softer formations would be impossible.

Problems made worse by increased weight are topics for study by industry groups. Among the most important are: (1) crooked hole; (2) drill-collar cost and maintenance; and (3) bit life as related to weight and rotary revolutions per minute. All of these problems are now much less troublesome than they were 2 years ago.

Drill Collars

The changes in drill-collar practice in the last 2 years are not really changes. They are a widespread acceptance of practices considered experimental 2 years ago.

In drilling 8¾-in. hole, 6¼-in. o.d. collars were the usually accepted drill-collar size 2 years ago. Often collars were to as small as 5¾-in. o.d. Now, 7 or 6¾-in. o.d. collars are the usual size in 8¾-in. hole. There are overshot fishing tools and wash pipe now available for conventional washover and fishing for retrieving 7-in. collars in 8¾-in. hole.

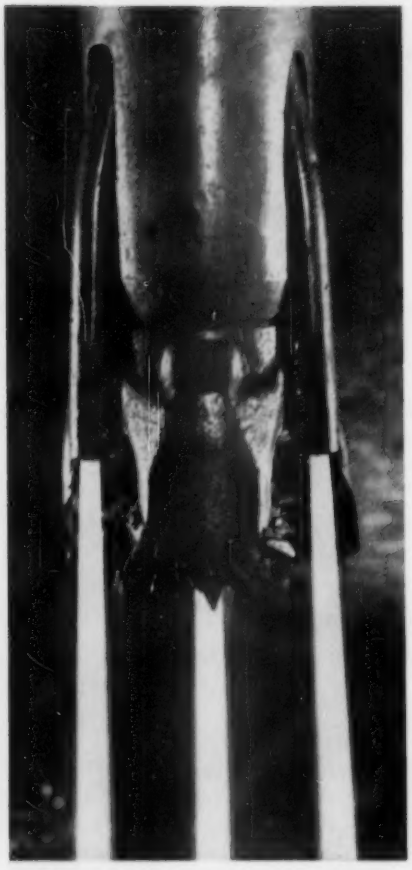
Two years ago, a few companies were drilling 8¾-in. hole with 8-in. collars to combat crooked hole. Because these collars were not retrievable by conventional washover, they were called "oversize collars." The use of oversize collars, 7-in. in 7⅞-in. hole and 8-in. in 8¾-in. hole, has become quite common.

Frequently only one, two, or three of these collars are used below a conventional string, but a number of companies have now run full strings on many wells. There has been success not only in keeping straight hole, but also in improved bit performance. One operator used a full string of 7¾-in. collars in 8¾-in. hole. These consistently resulted in greater footage per bit in fewer hours than on an offset location. The offset, drilled at the same indicated weight with 6-in. collars in 8¾-in. hole.

Apparently the larger collars minimize the loss of weight caused by buckling of the collar string against the wall of the hole. By this, they keep uniform loading of the bit. Using small collars above the bit results in bending of the bottom collar. There is a corresponding "walking" of the bit, alternately loading one cutter at a time. This walking speeds bit wear, bearing damage, and loss of efficient cutting action.

Some people expected many strings of oversize collars to be lost and many holes to be junked. This has not been the case. Eight-inch collars have been retrieved from 8¾-in. hole by taper tap on many occasions. At least three times, 7-in. collars have been washed over in 7⅞-in. hole by use of flush-joint 7⅝-in. wash pipe. A string of special wash pipe is available for washing over 8-in. collars in 8¾-in. hole. There is much less risk involved than was thought and there will be more general use of oversize collars.

Stress relief . . . An A.P.I. standardization committee studying drill-collar joint performance has conducted con-



BY USING this indexing sub, fluid flow can be alternated between conventional water courses and jet water courses. Fig. 1.

SPECIAL JOINTS were designed to handle the threaded-and-coupled drill pipe that replaced tool joints. Fig. 2.

trolled field tests on joints with such stress-relief features. The tests indicate these features lengthen the life of drill-collar joints.

In the Permian basin area today, many rig operators are using stress-relief features in all drill-collar joints. Even more use these features to combat box failures. These failures sometimes are excessive when the outside diameter of the collars wears down and the critical section of the box becomes thin. In some areas, corrosion speeds fatigue failure of the unengaged threads at the bottom of the box. Stress relief at this point removes the stress concentration effect of these threads, and will minimize the corrosion-fatigue problem.

More and bigger collars . . . One notable change in drill-collar practice in the Permian basin stems from the higher bit weight now used. This naturally brings a need for more drill collars or larger drill collars, or both. Two years ago, eighteen to twenty 6¼-in. o.d. drill collars were the average string in 7⅞-in. hole. Now it is common to see 20 to 25 such collars in a string. On occasion, some strings of 30 or more 6¼-in. collars have been run in 7⅞-in. hole.

The change to 7-in. o.d. collars in 8¾-in. hole has increased weight without increasing the number of collars in the string. But even here, more than 20 collars are sometimes used.

As the drill-collar diameter is reduced by wear, the result is loss of drill-collar weight and the weakening of the drill-collar joint box. This has prompted the use of hard-facing materials to retard outside-diameter wear. In the Permian basin, collars in continuous use lose ¼ in. of diameter per year. A 10-in. band of tungsten carbide hard-facing material about 20 in. above the pin shoulder has been surprisingly effective in retarding wear.

Where drill collars have been lengthened by welding on stubs of larger diameter than the body of the collar, it is essential to protect the stubs with a wide band of hard-facing material. Otherwise, they will soon be worn to the same diameter as the rest of the string.

Chert Bits

It was formerly believed that chert bits should be used in areas having at least 20 to 30 per cent chert. Or at least, they should not be used if a conventional hard-formation bit would make 25 ft. Chert bits are now replacing conventional bits in hard limestones and dolomites, especially when there are no interbedded shale streaks. Table 1 illustrates what improvement can be made through the use of chert bits.

TABLE I

	All regular bits	Chert bits and 1 regular bit
Interval, ft.	6,758-8,013	6,811-8,053
Footage	1,255	1,242
Total bits	22	5
Rotating hours	170¾	182
Cost per ft.	$12.69	$10.92

The table is based on $40 per hour rig cost and includes rotating hours, trip time, and bit cost. Such marked improvements are not to be expected when drilling with mud. The exact difference between using chert bits in clear water and in mud has not been fixed, but this problem is being given special study.

Jet Bits

Still a highly controversial subject is the merit of the jet bit. Among the users of jet bits, the proper methods of use are even more controversial.

Annulus velocities in the magnitude of 180 ft. per minute are no longer believed to be necessary to efficient jet drilling. There has been very successful drilling in the red beds with annulus velocities of 100 to 110 ft. per minute. This was done with 530 to 560 g.p.m., ½-in. nozzles, and 5½-in. o.d. drill pipe. The old concepts were 880 g.p.m. and ¾-in. nozzles. Horsepower required to get comparable results was 567 less at pipe point.

Many operators use jet bits and enlarged nozzles to relieve pumps and engines. They give no regard to nozzle velocity, bit horsepower, impact force, or annulus velocity, and yet believe that jet bits pay off.

Still other operators do not run jets at all. They believe that the return is not justified by the additional cost. Both cases are justified in their respective places.

Tests are being conducted to care-

THE AUTHOR

R. J. Bromell is chief drilling engineer, Great Western Drilling Co., Midland, Tex. He graduated from University of Oklahoma in 1950 with a B.A. in petroleum engineering. After completing a training program, he worked as a production engineer with Phillips Petroleum Co. In May 1952 he joined Great Western as a drilling engineer and worked in that capacity until promoted to his present position.

FIRE in the producing zone during air drilling melted this bottom drill collar. Fig. 3.

THESE BITS, used with air as a drilling medium, drilled roughly 700 ft. in about 28 hours. Fig. 4.

fully evaluate jet-bit performance. An indexing sub, Fig. 1, is being used to alternate fluid flow through conventional water courses and jet water courses. A comparison can be made in the penetration rate of alternate intervals. This tool can also be used to change size of jets while drilling. In this way, relations can be established among the many variables of jetting.

Drill Pipe

Jet bits have caused many contractors to change to larger drill pipe. The once popular 3½-in. o.d. pipe has given way to 4-in. o.d. and 4½-in. o.d. pipe. More 11 or 12¼-in. intermediate holes are now being drilled with 5½-in. pipe than several years ago.

At first glance, the present-day trends toward larger pipe seem to be reverting to old practices. Contractors knowing the hydraulic advantages of the larger drill pipe prefer using it, despite the extra weight in hoisting and higher initial cost of the pipe.

Although drill collars are the principal source of weight, some pipe weight is still used by the contractor especially with 5½-in. o.d. pipe. This practice cannot be entirely criticized. The large demand for drill collars and need for weight can often justify using some pipe weight when using 5½-in. o.d. pipe.

Cost-conscious contractors and operators are looking over other old discarded practices. One of the significant "finds" from the past is threaded-and-coupled drill pipe, viz., drill pipe with couplings instead of tool joints. (Fig. 2.) On wells of medium depth, 5,000 to 6,000-ft., one string of 4½-in. o.d. Grade D drill pipe with couplings drilled 152,000 ft. A second string is still in use after 95,000 ft. of hole.

Improved metallurgy may make it possible to use smaller rigs on deeper wells by using thin-walled pipe with higher strengths than present drill pipe. This type drilling has been going on for some time in California. It has been slow to start in the Permian basin, perhaps because of the severe pipe-wear conditions.

Drill casing and tubing . . . One major company is evaluating the use of drill tubing and casing which it has found successful in California. A special connection was designed to overcome the major disadvantages of the tubing in use in California. Pipe having this special thread has drilled 21,000 ft. of hole. It is believed that the major objections have been overcome. The joints are easy to stab, and have rapid make-up and breakout. They show little tendency to make up while drilling.

Slower rotary speeds, education of personnel, use of power tongs, and economic incentive may all help to make thin-walled drill pipe with couplings a practical tool in the hard-rock country.

Pumps

Jet bits more than anything else, have pointed out the lack of knowledge of pump and rig horsepower requirements. Everything from large-horsepower pumps and small engines to small-horsepower pumps and large engines could be found. A rig balanced as to draw works, pump, and engine horsepower was the exception. Most contractors are uncertain of what is really required.

The first tendency was to buy large pumps and larger engines. Results from rigs boasting 1,800 to 2,000 maximum horsepower and pumps from 600 to 850 hp. were quite impressive for a time. Then, small rigs began to compete with and, in some cases, surpass performance by the big rigs.

Obviously, other factors such as personnel, weight on bit, rotary speed, mud, and bit types entered into the picture. To this day it is impossible to evaluate the effectiveness of each.

For West Texas-New Mexico, it is gradually being accepted that the need for large pumps, 600 to 800 hp., is limited. Better flexibility and lower drilling costs can be had with pumps in the 300 to 500-hp. class. The smaller pumps are used for jetting in small holes on 5,000 to 7,000-ft. rigs. The larger pumps are used in parallel on large intermediate holes then singly on production string holes of deeper wells.

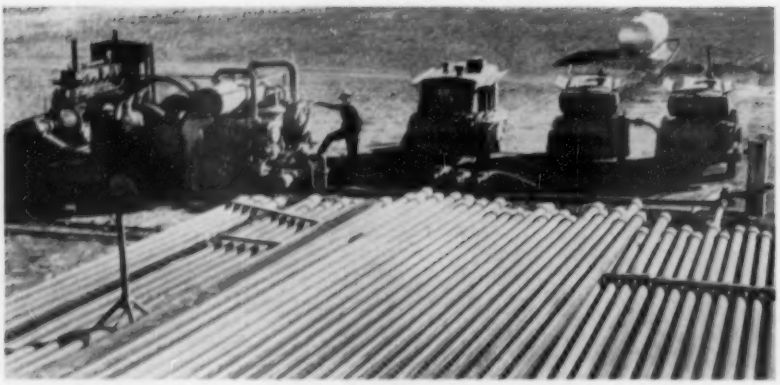
There has been some series of compounding of pumps. The parallel application of pumps or overstroking of pumps has been more generally accepted as a means of meeting hydraulic needs.

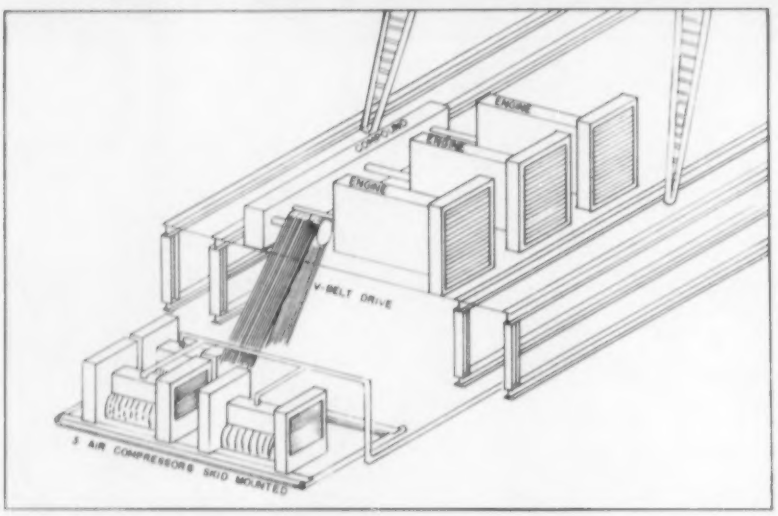
Air and Gas Drilling

Air or gas as a drilling fluid has been used in the Permian basin. Results have been much the same as in other areas. Water-bearing formations are the major trouble. Too much water makes it impractical to air lift; and very small amounts of water permit packing of cuttings on drill pipe and hole walls. The latter often results in stuck pipe.

Opinions on what is needed to properly drill with air or gas vary widely. Some operators think 1,500,000 cu. ft. per day at 120 psi. is enough. Others think 3,500,000 cu. ft. per day at 1,200 to 1,500 psi. will be needed. Obviously, the difference of opinion is due to the varied conditions encountered. The lower volumes and pressures may be enough if depths are shallow and there are no water sands.

Introduction of small amounts of water to further moisten cuttings and prevent sticking may require more air volume. Certainly, aerating mud columns will require greater pressures. The ratios of moisture and gaseous fluids between the extremes of mist and aerated muds present numerous problems. What is





THE PORTABLE COMPRESSOR layout pictured above is a new wrinkle that makes use of rig power. The layout sketched below, though not quite as new, is nevertheless a great advance over previous layouts of this type. Fig. 5.

needed, how much improvement to expect, and the ultimate saving will vary as the ratio varies.

Some cases . . . The following cases are selected from some of the operations in the basin area. In Caprock field of Lea County, New Mexico, three wells have been drilled in with air into the Queens sand. Prior to this, there had been no successful completion drilling in with rotary tools using mud in this immediate area. The first well drilled in with air was completed as a flowing well. The other two have been dry holes outside the field.

On the well which was completed, while drilling into the pay section a fire in the hole was ignited by a piece of burning rubber from the lining of an air hose. The only evidence of the fire at the surface was a puff of white smoke from the flow line. However, the bottom drill collar became hot enough to melt. The fire was extinguished when air circulation was stopped (see Fig. 3).

In another area, southeast of Hobbs, N. M., a section of 8¾-in. hole was drilled with air, beginning below the intermediate casing at 3,100 ft. Drilling proceeded to approximately 4,500 ft. where water in the hole forced a return to mud as a drilling fluid. A comparison of this well with a diagonal offset is shown in Table 2. Fig. 4 shows the two bits used with air. The one on the left drilled 780 ft. in 28½ hours and the other drilled 613 ft. in 27¾ hours.

TABLE 2

	Air	Mud
Hole size, in.	8¾	12¼
Footage drilled	1,293	1,412
Number of bits	2	12
Rotating hours	56¼	231½
Weight per inch of diameter, lb.	1,140-2,860	2,860-4,100
Revolutions per minute	65-70	75
Approximate interval drilled, ft.	3,100-4,400	3,100-4,500
Volume circulated, cu. ft. per day	1,900,000	
Air pressure, psi.	60-90	

A 3,600-ft. well, also in New Mexico, was drilled from under the surface pipe to 3,277 ft. with air. The first bit drilled from 1,185 to 2,880 ft. at an average rate of 60.6 ft. per hour. The second bit drilled from 2,880 to 3,277 ft. Drilling rate of 5 ft. per minute were obtained with 30,000-lb. weight, but crooked hole forced weight to 10,000 lb. Average penetration rate for six wells in the immediate vicinity of this well was 23.3 ft. per hour; and bits averaged 632 ft. for the interval drilled by the first bit.

Four cores cut from 3,277 to 3,364 ft. had 100 per cent recovery. There was difficulty while coring because of fluid entry into the well bore. Practically no cuttings were circulated while coring and reaming the core hole. Coring on the other six wells using mud averaged 2.5 ft. per hour as compared to 11.4 ft. per hour on the well drilled with air. The well was mudded up at 3,364 ft. and cored to total depth.

Two wells drilled by the same company in Val Verde County, Texas, are compared in Table 3.

TABLE 3

	Gas	Mud
Hole size, in.	8¾	8¾
Footage drilled	7,251	7,263
Number of bits	84	154
Feet per hour	9.25	7.2
Rotating hours	783.5	1,008.75
Weight per inch of diameter	250-2,000	4,500-5,700
Revolutions per minute	70	75
Interval drilled, ft.	1,510-8,761	1,500-8,763
Volume of gas, cu. ft. per day	1,500,000	
Gas pressure, psi.	75-100	

The gas-drilled hole was troubled by crooked hole as shown by the light weights. Despite this, the results were very impressive.

The interest that has arisen in recent months in regard to air and gas drilling has prompted compressor manufacturers to alter portable equipment. Two common types are illustrated in Fig. 5 with the newer arrangement, on the top, utilizing rig power.

Feed Controls

Comparisons of wells with and without automatic feed controls are few. One report given by a major company did not find much in favor of the automatic feed controls. However, data compiled by another company show a marked improvement in average drilling operations with the use of automatic feed controls.

Information on the operations showing improvement with automatic feed controls has been made available by Humble Oil & Refining Co. The wells are all located in the same field, drilled by the same rig, and employed the same personnel. With such ideal conditions, it would be difficult to find more

conclusive evidence than that presented in Table 4.

There was little improvement, as shown by Table 4, in the intermediate hole. In the interval from 4,000 to 7,100 ft., there was a 16.27 per cent increase in drilling rate. Wells completed in the lower Spraberry show more improvement in drilling rate as depth of wells increased. The automatic feed control raised penetration rate an average of 11.9 per cent over-all.

Hydraulic Equipment

In order to obtain some of the better features of steam or electric rigs, many new power rigs are being equipped with hydraulic couplings or torque converters. Biggest advantages are: (1) engines will not stall, thus preventing lugging at high loads; (2) crankshaft torsional vibrations are dampened; (3) engines can be synchronized within slip range; (4) shock loads on power trains are reduced; and (5) flexibility is greater.

Operators report that maintenance on power trains and engines has been reduced. One major company had a 50 per cent reduction in rig repairs. Another had 50 per cent reduction in engine maintenance. It is becoming common to hear reports of compounds running 2 or 3 years without a chain failure.

On pumps, too . . . Auxiliary and independently driven slush pumps are using converters and fluid couplings (see Fig. 6). On torque-converter-equipped units, the engines run at or near governed speeds. The pump strokes vary according to the load. Within certain limits, this reduces the number of liner changes. Care must be taken not to exceed the recommended pinion-shaft torque.

Transfer of power through fluid reduces the shock loads throughout the engines, power train, and pump. Maintenance costs are, therefore, lower.

Overspeeding power pumps as a means to get higher than rated hydraulic horsepower is easier when using hydraulic drives. An example is a 14-in. pump designed for 255 input horsepower at 65 s.p.m. With a flooded suction and fluid couplings it is used at 90 s.p.m. at 350 input horsepower. This pump has over 6 months' service at this load with no ill effects.

Hydraulic motors . . . Hydraulic motors and pumps are now more widely used to transmit and apply power. Shale shakers, water pumps, wire-line reels, blowout preventers, mud mixers, and other equipment are now operated by hydraulic power. Such power offers protection against fire when drilling with gas, and is flexible in its application. Maintenance costs are reportedly low as compared to other types of power.

One interesting application of hydraulic power transmission is in rotary-table drives. Advantages of rotary speed control and predetermined torque on pipe will make this type drive desirable. This type drive is still experimental.

"A more scientific approach to drilling problems, both in application of equipment on the surface and at the bottom of the hole, has resulted in great improvements in drilling time. Air and gas drilling, proper sizing of new equipment, use of lightweight drill tubing, and use of new techniques are bringing about reduced costs."

Acknowledgments

The author is indebted to many persons and companies for information. Special thanks are to: H. M. Rollins, Drilco Oil Tool; W. R. Johnston, Humble Oil & Refining Co.; L. P. Nell, Great Western Drilling Co., all of Midland.

TABLE 4—COMPARISON OF PENETRATION RATES FEED CONTROL

	Before installation of feed control	After installation of feed control
Surface hole:	7 wells	10 wells
Average depth, ft.	368	361
Average feet drilled per hour rotating	29.36	32.16
Average increase in penetration, per cent		9.53
Intermediate hole:	7 wells	10 wells
Average interval considered, ft.	3,642	3,758
Average feet drilled per hour rotating	44.59	45.39
Average feet drilled per bit	520.3	463.9
Average increase in penetration, per cent		0.179
Oil-string hole (through upper Spraberry):	6 wells	10 wells
Average interval considered, ft.	3,988-7,115 (3,127)	4,119-7,091 (2,972)
Average feet drilled per hour rotating	17.94	20.86
Average feet drilled per bit	175.3	199.5
Average increase in penetration, per cent		16.27
Oil-string hole (lower Spraberry):	5 wells	3 wells
Average interval considered, ft.	3,963-7,999 (4,036)	4,201-8,184 (3,983)
Average feet drilled per hour rotating	15.35	18.35
Average feet drilled per bit	153.5	151.3
Average increase in penetration, per cent		19.5

TORQUE CONVERTERS like the one attached above to an independently driven slush pump are now being widely used in the Permian basin. Fig. 6.

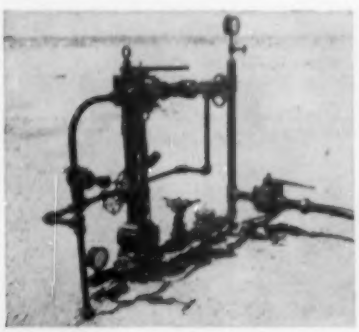
Kennametal* proved best by over 15 years of service in the oil industry

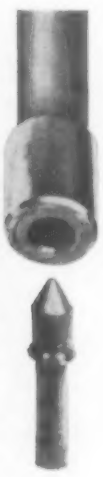
Provides many distinct advantages and benefits

Kennametal tungsten and titanium carbide compositions offer many production-increasing and cost-cutting advantages in lifting oil from great depths. First, is the long-life and wear-resistant qualities of Kennametal provided by its high resistance to corrosion, to spalling due to ball pounding, to sand abrasion, and to deformation under impact. Its high hardness prevents pitting and wire drawing.

Users' reports over the past 15 years indicate that Kennametal will last 20 times longer than steel and three to five times longer than special alloys. Ball and seat failures are cut, string pulling and pump repair costs reduced and well downtime and production losses held to a minimum.

It will pay you to try Kennametal balls and seats, balls and sleeves, cone valving, or other parts to combat wear, impact failure and corrosion. Kennametal costs you less in the long run. For further information, contact your regular supplier, or write to KENNAMETAL INC., Latrobe, Pennsylvania.





Kennametal ball and sleeve inserts are standard equipment in Kobe Free-Pump valves, selected by Kobe engineers after tests of various materials. In one operation, Kennametal in a Kobe valve plate operating at 50 to 80 closures per minute, has survived 9,000,000 closures under 3200 psi in oil and salt water fluid, produced from 8000 feet. Parts are acceptable for re-use and could easily give another 10 to 30,000,000 closures under these conditions.

Kennametal wear parts in this Otis bottom hole regulator provide 12,000,000 closures under 1200 psi in sand-sulfide fluid. Used parts illustrated have already given 3,628,000 closures in six months service, from 7000 feet.

*Registered Trademark

INDUSTRY AND

KENNAMETAL

. . . Partners in Progress

by W. L. Nelson
Technical Editor

PROGRESS IN METALS

Application of Metals and Alloys in Petroleum Refining

Part 7

THE applications and services listed in these eight parts (September 1954-April 1955) summarize much of the material published on the Progress in Metals page since January 1953. The compositions of the various alloys or steels listed here were published in the form of an alphabetical list in the issues of September 14, 1953-January 4, 1954.

Any listing of applications will obviously be incomplete and note especially that the most common materials such as gray cast iron, malleable iron, carbon steel, ductile iron, brasses, bronzes, etc., are seldom listed even though they may be used more widely than the alloys or alloy steels.

Equipment, Corrosive Agent or Service	Some of the Materials That Have Been Employed*†
Sulfur:	
Tank cars	Aluminum allows
Molten or vapor	Aluminum allows
Sulfur dioxide:	
Moist castings	Type 316 stainless (18-8-3), monel, nickel, and aluminum alloys
Sulfuric acid:	CF-12M (18-8-3) Cr-Ni-Mo steel
25 per cent boiling	Carbon (Karbate), lead linings, chemical tile
75 per cent at 275° F.	Carbon (Karbate), Hastelloy A, B, and D (castings)
96 per cent at 176° F.	Carbon (Karbate), Hastelloy A, B, and D (castings)
Over 96 per cent cold	Carbon (Karbate), and carbon steel
Over 96 per cent cold valves or pumps	Types 316 or 304 stainless
All concentrations and temperatures	Duriron, Corrosiron and Hastelloy B
Dilute at 180° F. thermocouple tubes	Lead or monel
Fuming	Hastelloy C
Sulfurous acid (or SO_2)	Type 316 stainless (18-3-3), monel, or nickel
Sulfide corrosion at 500° F. and up—	
Pipe-still tubes	2-9 per cent chromium moly steels
Linings, vessels	Types 302, 304, 405 or 410 stainless steels
Linings, vessels (also naphthenic acids)	Types 316 or 317 stainless
Gas coolers or sour crudes	Aluminum alloys, Alclad
Sulfide corrosion—expensive equipment—	
To 500° F.	5 per cent chromium steel
450°-800° F.	7-12 per cent chromium steel
700°-1,000° F.	12-18 per cent chromium steel (with nickel)
Sulfide corrosion—lines and fittings—	
Up to 500° F.	Carbon steel
450°-800° F.	5-8 per cent chromium steel
700°-950° F.	7-12 per cent chromium steel
900°-1,000° F.	5-8 per cent chromium steel
Sulfide corrosion (extent of attack)	
Relative to carbon 54 per cent	1 per cent chromium steel
Relative to carbon 43 per cent	2 per cent chromium steel
Relative to carbon 35 per cent	4 per cent chromium steel
Relative to carbon 31 per cent	6 per cent chromium steel
Relative to carbon 24 per cent	9 per cent chromium steel
Relative to carbon 18 per cent	12 per cent chromium steel
Relative to carbon 13 per cent	18 per cent chromium steel
Relative to carbon 6 per cent	25 per cent chromium steel
Sulfidizing furnace atmosphere	(HF) 18-8 through 25-20 (HK) Cr-Ni stainless castings
Tanks	(See storage tanks)
Tappets or stems (steam valves)	Q & T 3140 steel
Thermocoupe tubes:	
Furnace — 2,200° F.	27 per cent Cr iron
2,400° F.	Nickel or porcelain
2,900° F.	Porcelain
Sulfide atmosphere 1,000° F.	Inconel
Steam 1,500° F.	18-8 Cr-Ni steel
2,000° F.	Inconel
Sulfur (molten) 500° F.	Monel or aluminum alloys
Dowtherm	Nickel or porcelain
Dilute H_2SO_4 180° F.	Lear or monel
Hydrochloric acid 20 per cent 110 or 10 per cent 140	Monel
Tools—safety—for pump rooms, tank cars, etc.	Berryllium copper and aluminum bronze
Tubes (pipes still)	(See Furnace Tubes) and (Oxidizing Atmospheres) and (Sulfide Corrosion, extent of attack)
Tube supports	(See furnace castings)
Vacuum tower: Top and vapor lines with sulfide corrosion	Type 347 stainless

*Abbreviations—Type (302, 316, etc.) means A.I.S.I. designations. Q and T means "quenched and tempered." HT means "heat treated." Carb. means "carburized and case hardened." Numbers as 3140, 2335, etc., refer to S.A.E. steel designations. Chemical elements—C, carbon; Ni, nickel; Cr, chromium; Va, vanadium; Si, silicon; Mo, molybdenum; Mn, manganese. HX, HT, etc. are designations of the Alloy Castings Institute.

†Obviously, plain carbon steel, cast iron, brass, etc., are used for most services and they will not always be listed. Likewise, many materials have been omitted because their use has escaped notice.

Another Example of Efficient Power at Lower Cost

Warren Petroleum Adds Horsepower... and new economy... with Cooper-Bessemer GMVA's

● There was no guesswork when Warren Petroleum Corporation picked Cooper-Bessemer compressors for their new Saunders Gasoline Plant near Lovington, New Mexico. They *knew* by experience in other of their plants that they could count on these modern units for outstanding performance. They found, too, that new GMVA's offer unequalled operating economy.

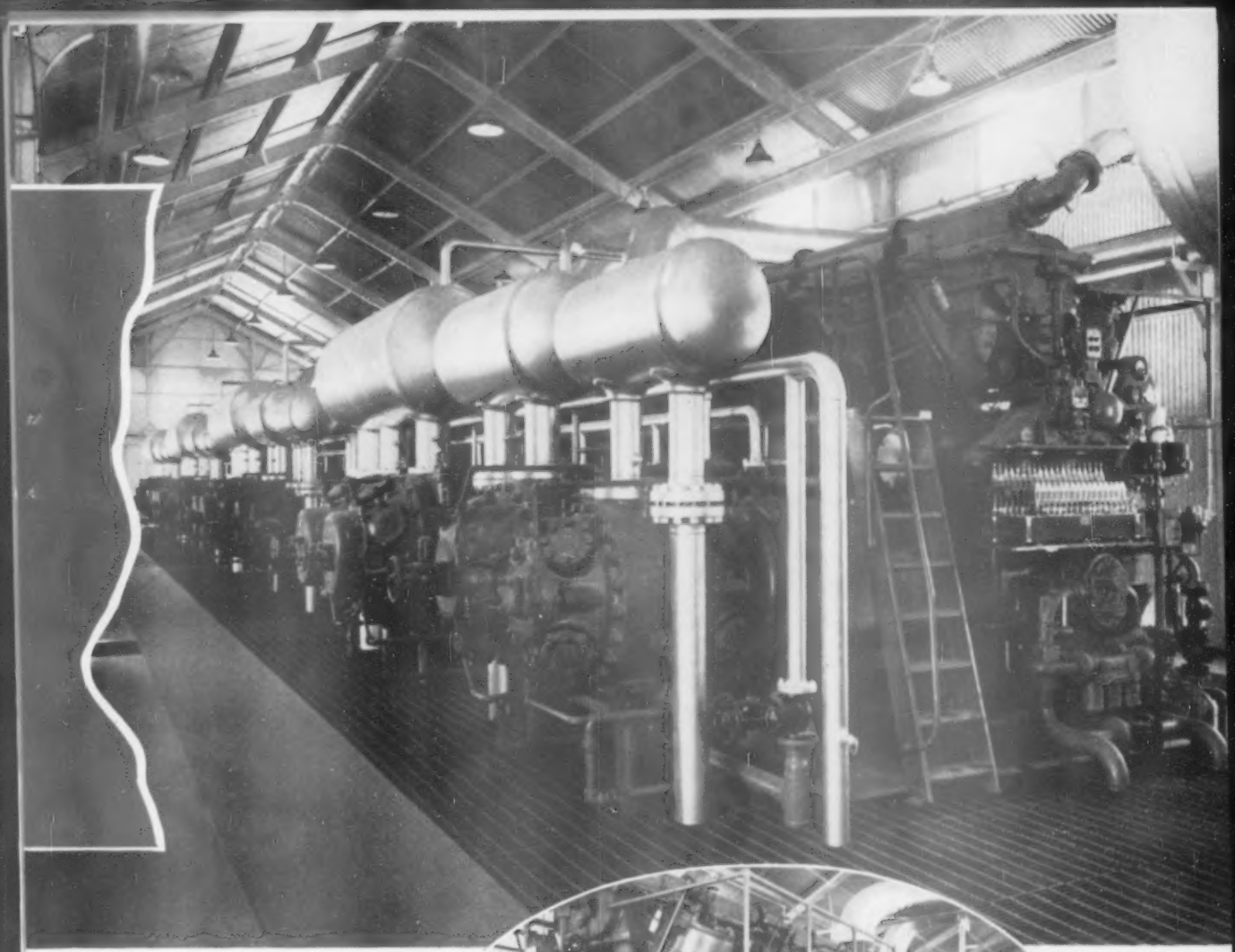
Shown opposite are the five new GMVA V-angles that handle the compressing for production of liquid petroleum gases and natural gasoline.

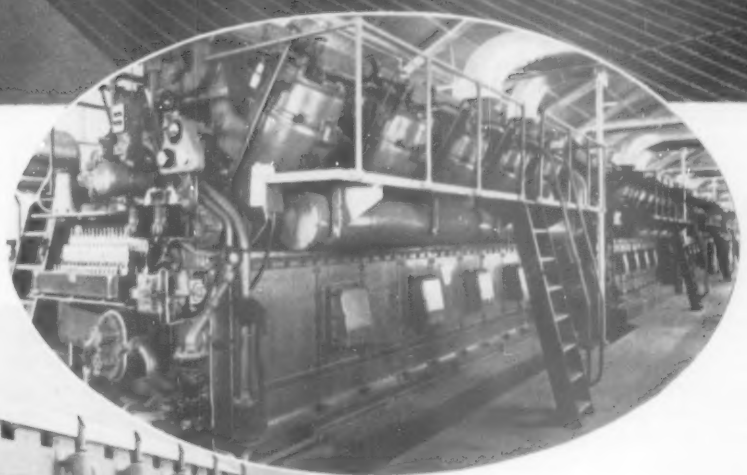
These 10-cylinder GMVA's, rated 1195 hp at 300 rpm at 4200′ altitude, are the latest Cooper-Bessemer advancement in the 540 to 1350 hp range. Offering a 10% reduction in fuel consumption, good air ratio to all loads, higher horsepower ratings with no space increase, and many other money and maintenance saving features, Cooper-Bessemer units are a "natural" when you're thinking of an increase in compressor facilities.

For any compressor need from 220 to 2500 hp, there's a Cooper-Bessemer V-angle — GMXA — GMVA — GMWA — that offers unmatched operating efficiency and peak economy. Get complete-line catalogs and further information from the Cooper-Bessemer office nearest you.

Compressors

New York Washington, D. C. Bradford, Pa.
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.





Here are two different views of the Cooper-Bessemer GMVA compressors in Warren Petroleum's Saunders Plant.

Housed inside the Saunders gasoline plant are five Cooper-Bessemer 1195 hp GMVA's, totaling 5975 dependable compressor horsepower.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

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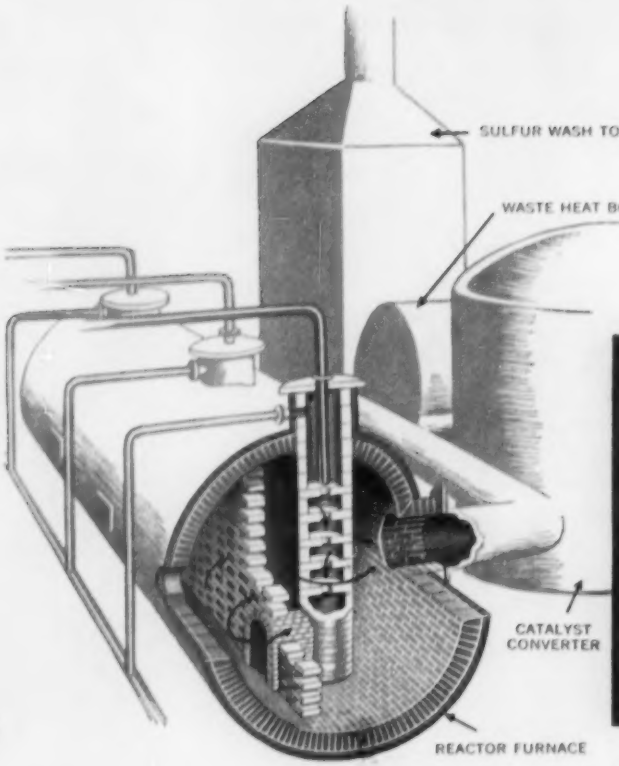

The dependable Mathieson Furnace is the key to a safer sulfur plant

The Mathieson furnace is a cylindrical horizontal kiln built in one or more sections with manifold connections for parallel operation. Each section is complete in itself with its own special packing section to assure uniform oxidation. Combustion takes place on the surface of the hot firebrick, eliminating need for burners and preventing unburned H_2S from escaping.

The Fluor-Mathieson sulfur recovery process has a distinct advantage over other methods of producing elemental sulfur from waste hydrogen sulfide because of the design of the Mathieson furnace. Outstanding in its simplicity and particularly in its safety factor, the Mathieson furnace entirely runs itself. It is not affected by the composition of the gas, by the fluctuations in feed gas rate, or even by a complete interruption of feed gas. It is possible to shut down a Mathieson furnace for as long as 60 hours and resume operation simply by readmitting the gas stream. Reaction starts immediately on the surface of the mass of hot brickwork, *leaving no possible chance for unburned H_2S to escape.*

The Mathieson reactor furnace is the only one in sulfur plant use today based on recuperative heating. All others employ burners of one sort or another which must be relighted if flame is extinguished due to a fluctuation or interruption of feed gas or for any other reasons. To prevent escape of unburned H_2S, burner-type furnaces are equipped with flame detectors, automatic relighters and other emergency devices which are subject to failure. These are not necessary on a Mathieson furnace.

Fluor-built sulfur plants operate at a 400° to 500° F temperature level at the catalyst beds with no danger of flooding the beds with sulfur. With burner-type kilns, should the flame fluctuate and catalyst reaction occur at too low a temperature, the catalyst beds are plugged with liquid sulfur, requiring shutdown. Catalyst in the Fluor-Mathieson process need only be changed every 3 to 5 years.

The Mathieson furnace can handle much leaner gases than other processes. If economically feasible, the Fluor-Mathieson process can recover sulfur from an H_2S gas stream with a sulfur concentration as low as 15% (dry basis). An internal brickwork recuperative heat exchanger incorporated into the furnace makes this possible. The temperature of the feed gas is preheated sufficiently before it reaches the reaction zone for more thorough combustion. This feature is exclusive with the Fluor-Mathieson design.

The first sulfur plant on this continent utilizing this process was built by Fluor for the Southern Acid and Sulfur Company in 1942. It is still in operation, producing a high grade (99.97%) sulfur. Since then Fluor has built a significant number of sulfur conversion units incorporating the Mathieson process. For more information, write

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COMPRESSOR MAINTENANCE—5

Improving Engine Lubrication by Viscosity Control

by H. B. DeBenedetti

VISCOSITY values must be effectively controlled to prevent the failures discussed in preceding installments. How do we do this? By sampling crankcase lubricants frequently enough to prevent the use of excessively high-viscosity lubricants, and by minimizing the condition which causes the viscosity increase.

Sampling frequence must be set for each individual engine. It will vary with the rate of combustion-gas leakage. This leakage in turn is dependent on cylinder-wall taper and concentricity, conformity of the rings in the cylinder, ring-end gap, piston-ring groove-ring seats, clearance of the rings in their piston grooves, and the amount of carbon behind the ring.

How much wear? . . . The particular engine should be analyzed closely. One must determine the maximum values of wear allowable for controllable performance. How much wear should take place before pistons should be regrooved and over-width rings used? How much cylinder wear and piston clearance is allowable before reboring or relining is necessary? What types and combinations of rings should be used at various amounts of wear?

The engine operator can answer these questions by keeping and analyzing good maintenance and operating records. We have done this and know at what clearance we should reline our power cylinders. We have found ring combinations which are giving us excellent blowby control. Our program of blowby control has stopped crankcase troubles. Lube-oil viscosity increases can be reduced by good ringing and sound cylinder and piston practices.

We now get from two to three times more use out of our crankcase oils. This improved performance is the result of our power-piston ring-belt area studies and changes.

Rings . . . The following description is given of the rings which we have tested. Tests were all made on first runs following cylinder relining so that an accurate comparison could be made. This first ring combination described below has given us the best blowby control. Ring types are described in the order in which they are installed on the piston (starting from the top).

Test 1: Two straight-cut, one two-piece 180° L.A.P. seal ring, one upper scraper compression with two-coil spring-backed, ventilated, lower oil rings.

Test 2: Four lap-ended step-seal compressions with two ventilated-scraper and inner oil rings.

Test 3: Two step seals, two straight-cut tapered compressions with two wide-channel ventilated coil-spring-loaded oil rings.

Test 4: Four angle or straight-cut compressions with two ventilated-scraper and inner oil rings.

Records of equipment . . . We keep complete records of our compressors and engines. These records include dimensional data and parts expenditures at each overhaul. They also show maintenance work which is done between scheduled major turnarounds. Each overhaul is covered by a report which gives general conditions found on opening the machines, unusual items which are found during the overhaul, and an analysis and explanation (where possible) of wear and failure of parts. The reports also give recommendations for improvements of operating and maintenance procedures and changes in overhaul and repair frequencies.

The records and reports, which constitute the maintenance file on a machine, enable us to set up preventive-maintenance schedules and determine overhaul frequencies. Our ultimate goal is to extend the interval between overhauls. We believe that we can only do this by keeping and analyzing records.

Author is with the Tide Water Associated Oil Co. manufacturing department, Avon refinery, at Associated, Calif. From paper presented at C.N.G.A. Los Angeles meeting.

THIS SERIES

Previous installments appeared on: February 7, 1955, p. 129; February 14, 1955, p. 133; February 21, 1955, p. 145, and March 7, 1955.

NEXT SERIES

The subject will be on additives for lubricating oils. The series will cover antioxidants, detergent-dispersants, corrosion inhibitors, V.I. improvers, pour-point depressants, antifoam materials, film-strength agents, and dyes.

FILL YOUR CASING AUTOMATICALLY

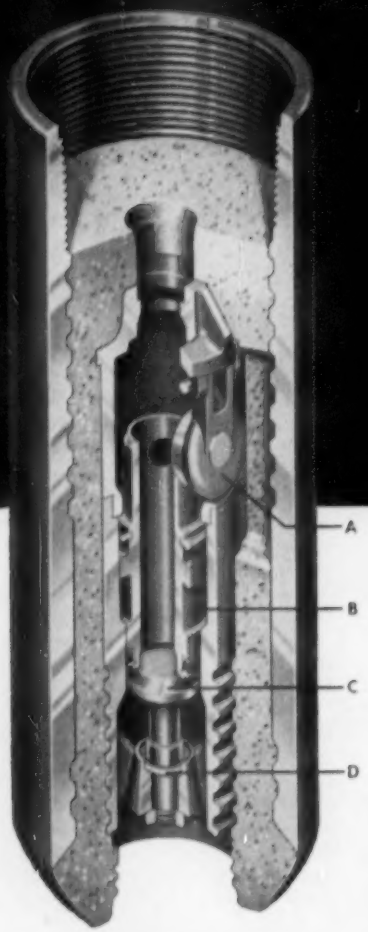
...from the bottom...while it's being run

with BAKER

- **DIFFERENTIAL FILL-UP SHOES** *and*
- **DIFFERENTIAL FILL-UP COLLARS**

Here's what DIFFERENTIAL FILL-UP Equipment does . . .

Permits the casing to *fill automatically from the bottom*, while it is being run, to within 90% of the fluid level of the annulus (using a shoe OR a collar)—or to within 81% of the fluid level of the annulus (using *both* a shoe AND a collar). In addition, a back-pressure valve is present to be used at the *discretion of the operator*, for "floating" or for cementing.



Baker DIFFERENTIAL FILL-UP Shoe, Product No. 1081.

A—Flapper Valve functions only at discretion of operator.
B—Sleeve Valve operates to control rate of flow and volume of "fill-up" fluid.
C—Sleeve Valve Seat.
D—Shear Ring is sheared. Flapper Valve now functions for floating or cementing.

Here's how Baker DIFFERENTIAL FILL-UP Equipment will aid you to avoid danger, increase rig efficiency, save valuable time and promote safety...

REDUCES THE DANGEROUS "RAM EFFECT" thus minimizing the hazard of breaking down a potential lost circulation zone.

SAVES COSTLY DRILLING MUD that might otherwise be lost to the formation due to the "ram effect."

MINIMIZES DAMAGE TO MUD CAKE on the wall of the hole. The majority of the fluid displaced as the casing string is lowered enters the casing instead of flowing up the annulus and causing possible damage to the mud cake.

REDUCES DANGER OF STICKING CASING by reducing to a minimum the "no-motion time" formerly required to fill casing at the surface—extremely important when running casing in directional holes or sloughing formations.

SAVES ONE-HALF THE RUNNING-IN TIME plus the proven advantages of Baker Floating Equipment, including a back-pressure valve for cementing.

KEEPS THE RIG FLOOR CLEAN AND SAFE by eliminating the messy spill-over and splattering of mud present when casing is filled at the surface.

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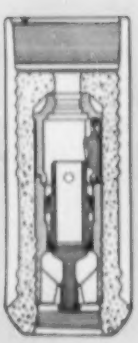
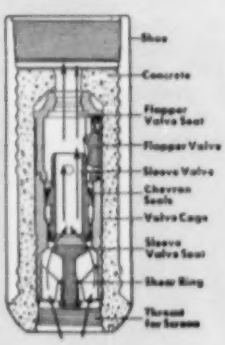
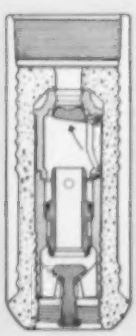


When running-in, the Sleeve Valve is in closed position in contact with the Sleeve Valve Seat. When the Sleeve Valve is in this position, fluid entry into the casing from below the valve is effectively blocked. The Sleeve Valve will be in the closed position whenever the height of the fluid column in the casing (the fill) EXCEEDS 90% of the height of the fluid column in the annulus.



When the height of the fluid column in the casing (the fill) is LESS than 90% of the height of the fluid column in the annulus, the Sleeve Valve moves upward away from the Seat and permits fluid entry into the casing through the bottom of the FILL-UP Shoe. During the casing run, the Sleeve Valve opens and closes according to the pressures imposed on its top and bottom areas and thus automatically regulates the degree of fill.



When it is time for cementing, pressure of approximately 1,000 psi is built up in the casing to shear the Shear Ring that holds the Sleeve Valve Seat in the supporting vanes of the Valve Cage. The Sleeve Valve can then move downward sufficiently to release the spring-loaded Flapper Valve, and thereafter the FILL-UP Shoe functions as a conventional Float Shoe.

Among the

Drilling Contractors

Hayes & Sprague, Inc., Los Angeles, will drill a deep wildcat test for Honolulu Oil Corp. in the Delta Farms area, 15 miles northeast of Coalinga, in Fresno County, California. Designation is 25 Indian-Westates, in 8-19-17. Plans call for drilling to the Eocene, about 11,000 ft., if necessry.

A. D. Rushing Drilling Co., Santa Paula, Calif., is under contract for a projected 6,000-ft. test to be drilled for Richard S. Rheem, of San Francisco, at Placentia, in the Los Angeles Basin of California. Location at 1 Placentia, in 25-3s-10w, is west of Richfield field, and east of Coyote field.

McFarland Drilling Co., Corpus Christi, Tex., has a new contract operation scheduled for northern Atascosa County, Southwest Texas. It is a 3,500-ft. Edwards test for Joseph W. Bailey, George Estes, and A. H. Cole, all of Corpus Christi. Location is in GC&SF Survey 16, near Leming, and about 3 miles northeast of Poteet field.

Liberty Drilling Co. is contracting for Texas State Drilling Co., of Houston, on a new 8,000-ft. wildcat test being drilled at 1 Thomas et al., in WCRR Survey 9, 5 miles southwest of Satsuma, in Harris County, Texas Gulf Coast. Location also is a mile southeast of Joyce Richardson field. The area is about 25 miles west of Houston.

Walker-Wilson Drilling Co. has contracts with Dietler & Oleson, Inc., of Denver, for two new wildcat tests in Logan County, northeastern Colorado. One, listed as 1 State, in 2-7n-52w, is 3 miles southeast of Sterling. The 1 Revers, in 27-6n-49w, in the southeastern part of the county, about 20 miles southeast of Sterling. Slick Oil Co., Ltd., is associated with Dietler & Oleson in the projects.

Wise Drilling Account, Tyler, Tex., is drilling for Watburn Oil Co. at a wildcat location 2 miles southwest of Glenwood, in Upshur County, East Texas. Location, at 1 Pitman, in the Joseph Manning Survey, is 2 miles north of production in East Texas field. Drilling is projected to 4,500 ft.

Carter-Beveridge Drilling Co. is under contract for another well, the third, which Shell will drill in the new South Pass Block 6 field, in the Gulf of Mexico off the southeastern tip of Plaque-

Heavy-duty assembly used by H. L. Rowley, Inc., Shreveport contractor, on a deep, rank wildcat test drilled for Southern Natural Gas Co. southwest of Bexley, in northwestern George County, in the pinewoods area of southeastern Mississippi. The test, 1 B. E. Green estate, recently abandoned, was drilled to 13,308 ft. in the Lower Cretaceous. John C. Howard is tool pusher on the rig.

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mines Parish, Louisiana. The discovery well was completed early this year as an oil producer at 8,337-49 ft. The second test, spudded late in January, still is drilling. Both it and the newest operation are projected to 8,700 ft.

Carter-Jones Drilling Co., Kilgore, Tex., has a rig in Elysian Fields field, in Harrison County, northeastern Texas, where it is contracting for Fred Whitaker. Current operation is at 1 Williams, in the Henry Harper Survey. It is scheduled for 6,500 ft. The area is 4 miles north of Elysian Fields.

Glasscock - Wilson Drilling Co., Shreveport, is scheduled for an 11,000-ft. wildcat test to be drilled for C. W. Glasscock and others in Lafourche Parish, southeastern Louisiana. Location is in 152-15s-16e, 2 miles southwest of the Rousseau area. It is listed as 1 Prater. This company also is continuing work for Sun Oil Co. in Kinder field, Allen Parish, where it now is moving to 1-B Kinder for another 8,200-ft. well.

Delta Gulf Drilling Co., Tyler, Tex., has started contracted drilling operations for Southwest Gas Producing Co. in the Midland gas area, Acadia Parish, Coastal Louisiana. This is a unitized development project with the first operation being 1 Hoyt, in 41-10s-1w. Hole is projected to 11,000 ft.

Fritz & Stewart Drilling Co. is Stanolind Oil & Gas Co.'s contractor on a wildcat operation getting under way 17 miles south of Zapata, in Zapata County, on Texas' Mexican border. The test, designated as 1 Vela, is projected to 8,500 ft. It is in Porcion 26.

T-W Drilling Co. is drilling on Humble Oil & Refining Co.'s third test in the Pass des Ilettes area, in the tidal marshes on the coast of Terrebonne Parish, southeastern Louisiana. Humble's first test, not completed, is standing as a potential gas discovery well after testing (last November) a 14,000-ft. sand. Its second test, southwest of the first, was abandoned in January as dry at 12,954 ft. The area is 5½ miles southwest of Dog Lake field, nearest production.

Regent Drilling Co., Ltd., Edmonton, Alta., has the contract for a projected 2,500-ft. Devonian test Canadian Fina Oil, Ltd., and Texaco Exploration Co. will drill 9 miles northeast of Red Willow, nearest railpoint, 13½ miles northeast of Stettler, Alberta Province, Canada. Location, in LSD 8, 4-41-17w4, is 17 miles northeast of nearest Devonian production.

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Pipeline Patrol

. . . Report on Construction

Shallow-Water Laying Barge Used in Gulf

Magnolia Petroleum Co. will begin operation this spring of the world's longest offshore pipeline. The line, operated by Magnolia for itself, Continental Oil Co., and Newmont Oil Co., runs from Burns Terminal on the coast of St. Mary's Parish, Louisiana, to Block 126 in Eugene Island field. Construction started last summer and about 32 miles was laid before bad weather halted the work. Laying of the concrete-weighed pipe was by conventional lay barge with ditch being provided by clam and jet dredge to give a minimum 3-ft. cover. The shallow-water lay barge is shown in the picture. For a detailed story of how the line was laid, difficulties encountered, etc., see page 118 of the March 14 Oil and Gas Journal.

Under Way, Contracted, and Planned

PIPELINE activity as reported below by the Oil and Gas Journal is compiled from information received from pipeline companies and contracting firms.

These projects include those planned, proposed, under way, and contracted. Uncontracted projects are indicated by • preceding the job.

Crude-Oil Pipelines

Ar-Mex Pipe Line Co.—Company has applications for two lines before the Office of Defense Mobilization Board for rapid amortization approval.

1. A crude-oil line from Albuquerque, N. M., to Phoenix, Ariz. This line would serve a 20,000-bbl. refinery being planned by Frost & Associates of Dallas.

2. A crude-oil line from Guernsey, Wyo., to Albuquerque.

• **Magnolia Pipe Line Co.**—Company will begin construction soon on 215 miles of 12, 14, and 16-in. pipeline along its crude-oil system from Midland to Corsicana, Tex. The expansion program also calls for doubling of pump horsepower of the six pump stations to a total 21,600 hp.

Magnolia Petroleum Co—This company will operate a 48-mile, 12-in. submarine pipeline for itself and Continental Oil Co., and Newmont Oil Co. The line will run to blocks off the coast of St. Mary's Parish, Louisiana, and will have a capacity of 50,000 bbl. per day. Brown & Root, Houston, has the contract and expects to be finished by the middle of 1955.

Minnesota Pipe Line Co.—Williams Brothers Co. has contract to build this 260-mile, 16-in. crude line from Clearbrook to Hastings, Minn. The line, to cost $12,500,000, is the southern end of a system which will move crude from Fosterton field, Sask., to Great Northern's refinery which is building in the Minneapolis-St. Paul area. Present plans call for completion by July 1955.

Shell Oil Co. and Murphy Corp.—These companies have announced plans for a 450-mile, 16-in. crude line from eastern Montana south into Wyoming. The line will deliver to big-inch carriers which start in eastern Wyoming.

Standard Pipe Line Co.—Company plans to build two crude lines. Applications are now before the Office of Defense Mobilization for rapid amortization approval.

1. A 350-mile, 16-in. crude line from Glendive, Mont., to Guernsey, Wyo., to connect with Platte Pipe Line Co.'s system there.

2. A 330-mile, 16-in. crude line from Wink, Tex., to Albuquerque, N. M. This line would serve a 10,000-bbl. refinery being planned by Frost & Associates of Dallas.

Texas New Mexico Pipe Line Co.—Firm has awarded contracts for 74 miles of crude lines in eastern New Mexico and West Texas. Ferguson Construction Co., of Eunice, N. M., will lay 43 miles of 8-in. from Maljamar station in Eddy County, New Mexico to Tulk pool in Lea County and Drickey pool in Chaves County, New Mexico. McVea & Barlow, Inc., Odessa, Tex., will lay 24 miles of 8 and 10-in. from Dora Roberts Ranch in Midland County, Texas, to Basin Pipe Line System's station at Midland, Tex.

Trans Mountain Pipe Line Co.—Engineers Limited Pipeline Co. has contract to lay 27 miles of 20-in. from Laurel to Burlington, Wash., and 9 miles of 16-in. of lateral to Shell Oil Co.'s new refinery at Anacortes, Wash. The $2,750,000 job will begin in spring and end in mid-summer.

• **Union Oil Co. of California.**—Planning construction of a 60-mile crude line from its

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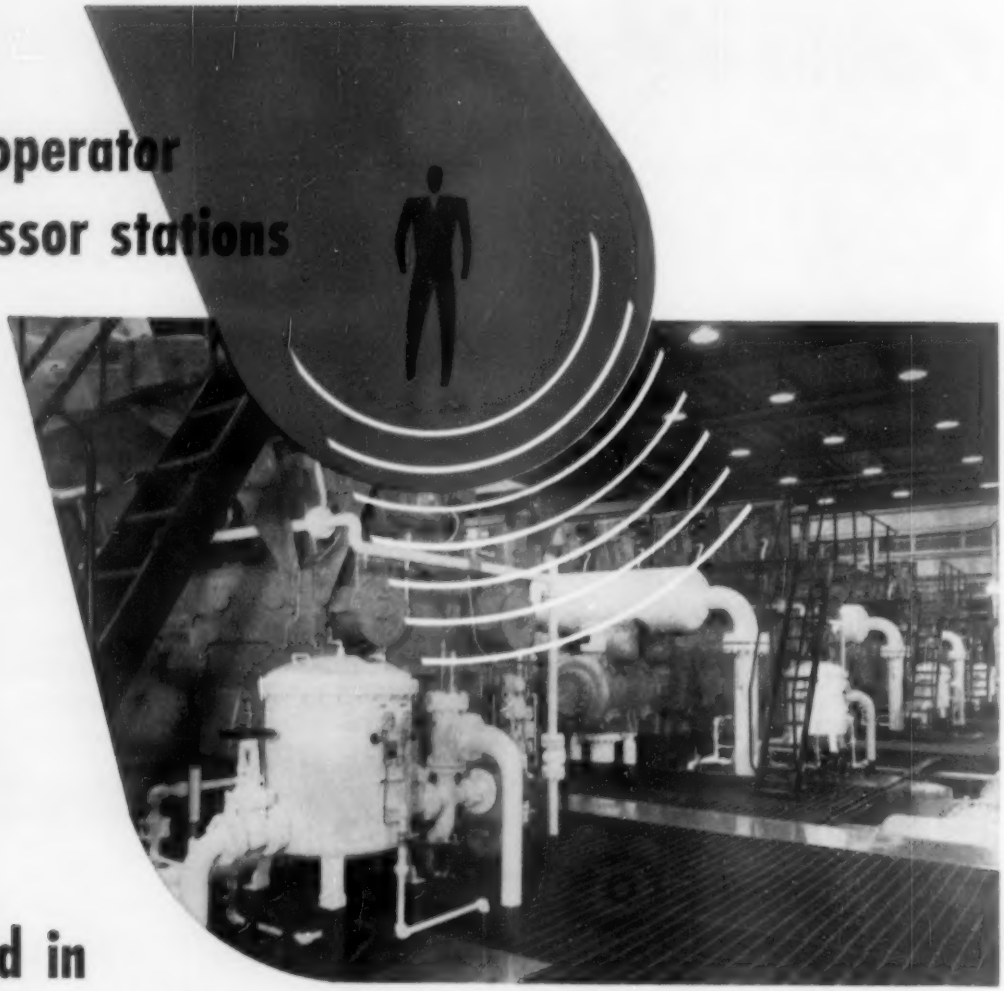

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Pipeline Patrol

Clara Valley field to its Wilmington refinery. 12-in. line. Bids being asked.

• **West Coast Pipeline Co.**—The off-again-on-again plans for this crude line from near Wink in West Texas to near Norwalk in California are presently before the Office of Defense Mobilization. A three-man board of nonindustry members recently recommended that the project be dropped. They questioned the ability of West Texas to produce enough crude to supply both the East and West Coasts in time of war. The three-man board favored building a line from California's Elk Hills Naval Reserve to be held in standby for possible future need.

Products Pipelines

• **American Pipe Line Co.**—Has received ODM approval to amortize 40 per cent of $178,000,000 with a rapid writeoff on proposed line to run from Gulf Coast area to New York City area. Bids for pipe requested.

• **H. W. Bass & Sons, Inc.**—Company is planning on a 152-mile, 4-6-in. L.P.G. line from Goliad Corp.'s plant in Live Oak County, Texas, to Corpus Christi.

• **California - Oregon Pipe Line System.**—103 miles 6-in., proposed, Crescent City, Calif., to Medford, Ore.

Cimarron Valley Pipe Line Co.—Subsidiary of Chicago Corp. is building an 81-mile, 6-in. products line from Chamlin Refining Co.'s refinery at Enid, Okla., to Oklahoma City. River Construction Co., of Fort Worth, is doing the work.

Great Lakes Pipe Line Co.—Company has awarded contracts in two sections on its 163-mile, 10-in. line between El Dorado, Kans., and Kansas City, Mo. Ray L. Smith & Son, Inc., are laying a 91-mile spread between El Dorado and Burlingame, Kans. M-R Co., Wichita, is working on the remaining 72 miles into Kansas City.

• **International Pipe Line, Inc.**—132 miles 8-in., proposed, Wrenshall to Minneapolis, Minn. Cost: $4,200,000.

• **Keystone Pipe Line Co.**—Company has ODM writeoff of 25 per cent for $1,875,000, 48-mile, 8-in. products line from Boot, Pa., to the Fullerton, Pa., terminal.

Malco Pipeline, Inc.—Company planning to build a 91-mile, 6-in. products line from its Prewitt, N. M., refinery to Albuquerque.

Moore Stoner Co.—Company has $2,500,000 tax amortization for a 200-mile, 6-in. products line from a connection with Oil Basin Pipe Line Co.'s terminal at Glendive Mont., to Minot, N. D.

• **Products Pipe Line Co.**—This subsidiary of Goliad Corp. has received a fast writeoff for 40 per cent of $126,000 and 25 per cent on $1,781,000 for L.P.G. line from the Wilcox natural-gasoline plant in Lavaca County, Texas, to Texas City. Panama-Williams Co. has contract. Completion scheduled for mid-summer.

Shell Pipe Line Corp.—65 miles of 12-in. products line from Baton Rouge, La., to Shell's Norco refinery. Houston Contracting Co. has contract. H. T. Muckley, Supt. Job held up indefinitely by right-of-way difficulties.

Sioux Oil Co.—Company will build a 55-mile products, 8-in. line from its Newcastle, Wyo., refinery to Rapid City, S. D.

Southern Pacific Pipe Lines, Inc.—This subsidiary of Southern Pacific Railroad Co. has announced plans for 800 miles of products line from Los Angeles to El Paso. Line sizes are 16-in. from Los Angeles to Colton, Calif., 12-in. from Colton to Phoenix, Ariz., and 10 and 8-in. from El Paso to Phoenix. Products will be pumped both ways into Arizona.

• **Sunflower Pipe Line System.**—Company proposes to build a 215-mile, 6-in. line to transport L.P.G. from six counties in western

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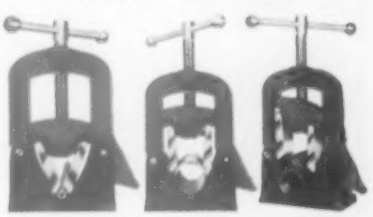

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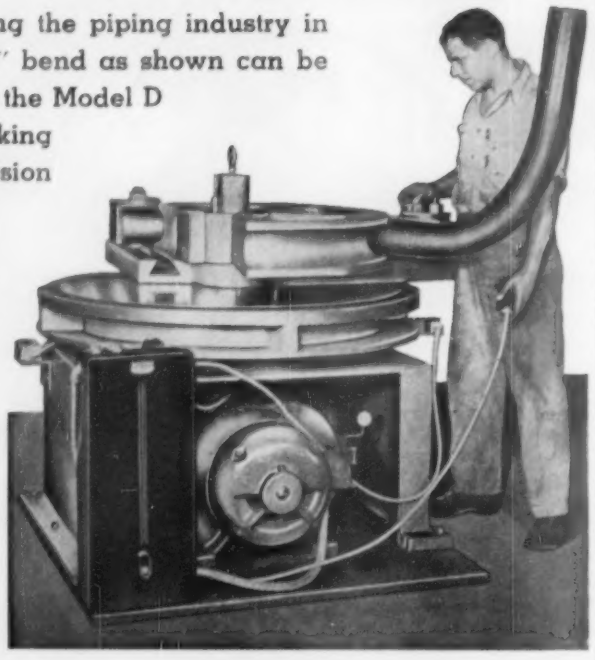

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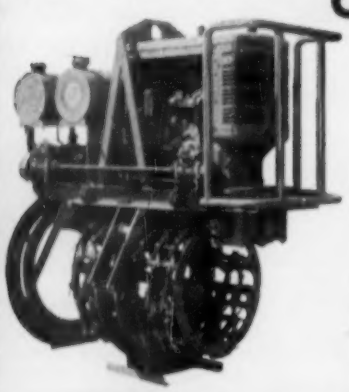

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Pipeline Patrol

Kansas to Wichita. Application approved by Kansas Corporation Commission.

Texaco-Cities Service Pipeline Co.—Company is laying 45-mile, 8-in. products line from Tulsa to Cushing, Okla. O. R. Burden Construction Corp. has the contract. Line is expected to be finished in April. Company will also build a pump station at Tulsa and two 30,000-bbl. tanks at Cushing.

Texas Eastern Transmission Corp.—Company has asked FPC permission to abandon "Little Inch" gas line. If permission is granted, company will spend $13,000,000 converting the line to a products line with a capacity of 235,000 bbl. per day.

U. S. Gov't. Alaskan Products Pipe Line.—600 miles of 8-in. under way from Haines northward through Yukon to Fairbanks, Alaska. Williams Bros., McLaughlin, Inc., and Marwell Construction Co. are doing the work. Pipeline work completed.

Natural-Gas Pipelines

• **American-Louisiana Pipe Line Co.**—1,121 miles of 30 and 22-in., 30-in., proposed, extends from North Tepetate, Acadia Parish, Lousiana, to near Detroit. The 22-in. starts near Payne, Ohio, extends to Bridgman, Mich. Estimated cost: $130,000,000. FPC approved.

• **Arkansas Louisiana Gas Co.**—136 miles of new line proposed, to be added to present system in Arkansas, Louisiana, and Texas. Estimated cost: $9,245,166. FPC approved.

• **Carolina Natural Gas Corp.**—185 miles 2-12-in., proposed later lines off Transcontinental in North and South Carolina.

• **Central Hudson Gas & Electric Corp.**—Company has filed application with FPC to construct 48 miles of 12-in. line from Albany to Kingston, N. Y. Line will be started and completed in 1955 if FPC approves.

• **City of Dalton, Ga.**—Proposes to build 39 miles of 8-in. from a point of interconnection with Southern Natural's Rome-Calhoun transmission line. Estimated cost: $2,940,000.

• **Clinchfield Coal Corp.**—Company has filed permit with Federal Power Commission for authority to build 16-mile, 12-in. line from Dickenson County, Virginia to near Osborne Gap, Ky. The company is primarily a coal producer.

• **Colorado Interstate Gas Co.**—365 miles 22-in., approved by FPC, Green River, Wyo., to Denver, Colo., 1954.

• **Colorado-Western Pipe Line Co.**—454 miles of undetermined size pipe planned between Cortez in Montezuma County and Denver. Line would serve towns of Montrose, Gunnison, Salida, Fairplay and South Platte, Colo. Estimated cost: $30,000,000. Company also plans 254 miles of laterals to service Colorado cities not now receiving natural gas.

328-mile line, proposed, to run from a point in La Plata County in southwestern Colorado over the Continental Divide along the eastern slope to serve Pueblo, Colorado Springs, and Denver. Estimated cost: $21,600,000.

• **El Paso Natural Gas Co.**—Company has future plans for a 370-mile, $35,000,000 line from Mountain Home, Idaho, to Reno, Nev. The company will buy the gas from Pacific Northwest Pipeline Co.

• Company plans to build 74 miles of natural-gas line and 6,925 additional compressor hp. in Texas, New Mexico, and Arizona. The cost will be $13,869,017. FPC approval received.

• Hope Natural Gas Co.—Proposing to build a 22½-mile extension of existing line from Boone County, West Virginia, to Logan-Mingo County line, West Virginia. Estimated cost: $930,000.

• **Houston Texas Gas & Oil Co.**—Company has proposed an 18-24-30-in. line from South Louisiana to Florida. Preliminary engineering,

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This versatile family includes *ElectroniK* indicators, recorders and controllers in circular and strip chart models, applicable to temperature, pressure, pH, power and dozens of other variables; square root flow meters for control applications; evenly graduated flow meters for cost accounting; thermometers, pressure gauges and liquid level meters; *Pyr-O-Vane* millivoltmeter controllers. Especially useful for graphic panels are the *Tel-O-Set* miniature indicators, recorders and controllers. Electric and pneumatic control systems range from the simplest to the most complex, including automatic program controls and complete systems developed for particular processes.

Working with these instruments is a full choice of primary elements . . . thermocouples, *Radiamatic* radiation elements, pressure-type and electrical resistance thermal systems, flow meter bodies, pH cells and many others. For final control elements, you can choose from a wide range of electric motorized and diaphragm operated valves. To complete the picture, there are more than 7000 non-indicating devices for controlling temperature, pressure, vacuum, liquid level and humidity . . . an unmatched variety of instrumentation made by the world's largest manufacturer of control equipment.

Honeywell cascade control maintains accurate reheater

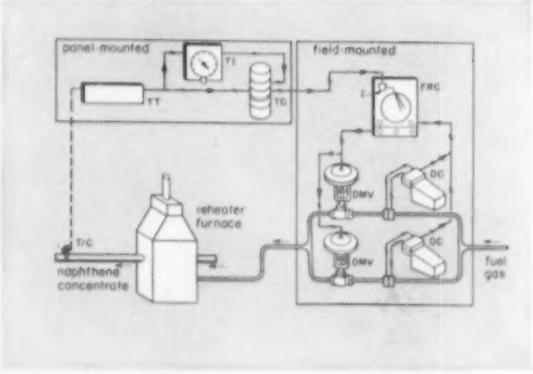
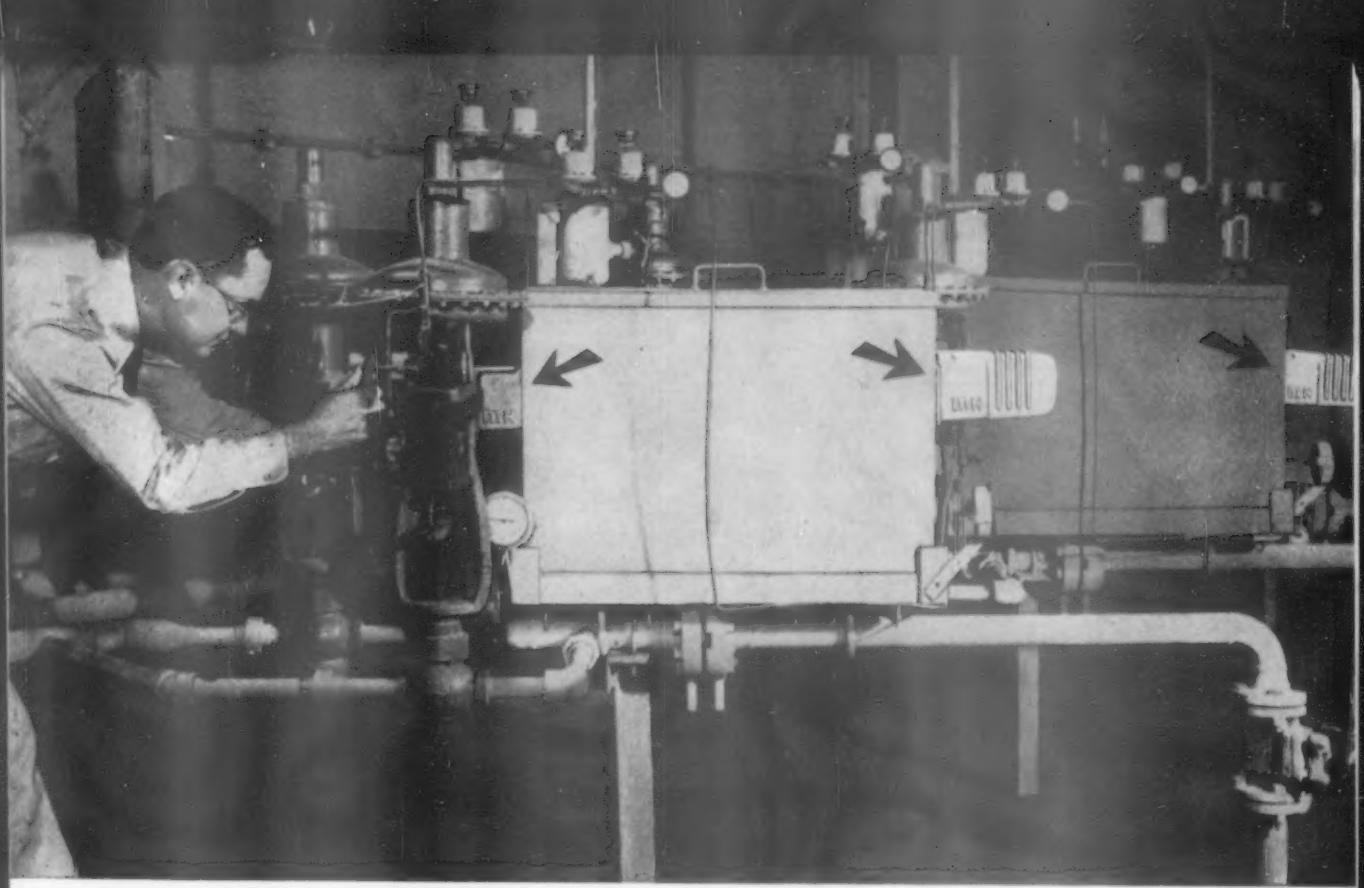


Diagram shows basic elements of temperature control system. Grouping ***Tel-O-Set*** *indicator, controller and temperature transmitter together minimizes control tubing runs . . . simplifies tuning of control action.*



Flow of fuel gas to reheater furnaces is transmitted to nearby controller by ***Differential Converters*** *(see arrows). Cascade control system actuates diaphragm valves in each line.*

temperatures in Sun Oil Plant

SUN OIL COMPANY'S $15 million petrochemicals plant at Marcus Hook, Pa., makes use of the most advanced control techniques to assure efficient production. Designed to produce toluene, benzene, xylenes and numerous valuable by-products . . . the plant features Honeywell graphic centralized control, plus supplementary field-mounted instrumentation in specific spots where local data is needed.

The Honeywell cascade system used to regulate reheater furnace temperature typifies the intricate control instrumentation required for many processes. The furnace feeds the *Houdriformer* unit, and must supply widely varying Btu output depending on the end product. The furnace has considerable control lag, and fuel gas may vary in composition and pressure. To overcome these factors, a *Tel-O-Set* instrument on the main panel measures temperature of heated stock and resets the control index of a Brown Flow Controller. The flow instrument is located near the furnace where fireman can check readings. This controller, in turn, regulates diaphragm valves in the two fuel gas lines supplying the furnace. Adjustable limit stops in the flow controller's *Indexet* unit prevent closing of the gas valves beyond safe limits during sudden surges in temperature. The result is exceptionally consistent, close-limit control.

Numerous other specialized control applications can be readily handled by Honeywell custom-designed cascade and ratio systems. A broad variety of instrumentation, and an extensive background of experience in petroleum processing control are ready to serve you. Your local Honeywell sales engineer will welcome the opportunity to discuss your specific application . . . and he's as near as your phone.

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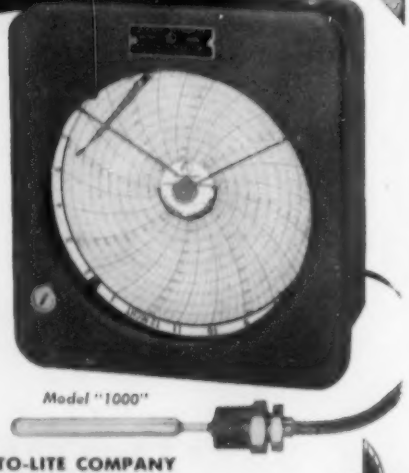

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TEMPERATURE RECORDERS

Pipeline Patrol

market surveys are completed. Early filing with FPC is anticipated by company.

• **Kansas-Nebraska Natural Gas Co., Inc.**—Proposes to construct 206 miles of 6-12-in. pipeline to add to present system in central and northeastern Nebraska.

• **Manufacturers Gas Light & Heat Co.**—40 miles, proposed, Allegheny, Washington and Beaver counties, Pennsylvania.

213 miles, 3 to 26-in., proposed, various points on system in Pennsylvania, West Virginia, and Ohio.

72 miles, 16-20-in., Doddridge, Wetzel and Marshall counties, West Virginia. Fulghum Contracting Co. doing work.

• **Michigan Consolidated Gas Co.**—25 miles, 12-in., proposed, from near Sparta to Muskegon, Mich.

• **Michigan Wisconsin Pipe Line Co.**—251 miles, proposed, 24, 18, 12, 6, and 4-in. loops. Majority will be in Wisconsin.

• **Missouri Public Service Co.**—136 miles, 8-10-in., proposed, New Franklin to Trenton, Mo.

24 miles, 10-in., Johnson County to Clinton, Mo. FPC approved. Est. cost; $600,000.

• **Montana-Dakota Utilities Co.**—Proposes to build 56 miles of 2, 4, and 6-in. line from its 12-in. Cabin Creek - Bismarck line near Gladstone, N. D., to the towns of Lefor, Regent, New England, and Mott, N. D.

• Proposed 34½ miles of 12¾-in. line to run from Baker-Glendive field in Montana to Rapid City, S. D., and 14 miles of 12¾-in. to replace various lines in Park County, Wyoming, and Carbon County, Montana.

Natural Gas Pipe Line Co. of America.—Company has proposed a 280-mile line from Wise County, Texas, to Panhandle field in Texas where it would connect with the NGPLCA to Chicago.

Natural Gas Producers, Inc.—This subsidiary of Colorado Interstate Gas Co. has approval of the Colorado Public Utilities Commission for a 48-mile, 10-in. line from northeastern Colorado to Denver. The company will also build 3 miles of 8-in. and 10 miles of 4-in. Entire project will cost $1,374,000.

Nevada Natural Gas Co.—Company plans looping program along its 114-mile line from Needles, Calif., to Las Vegas, Nev. Mileage and size are unknown but cost will be about $2,500,000.

• **New River Gas Co.**—50 miles, planned, Summers to Monroe counties, West Virginia, to Narrows and Dublin, W. Va.

• **North Dakota Natural Gas Co.**—This company has moved back into the gas picture in North Dakota with a bid to build a 274-mile, $11,017,200 system from Tioga to Fargo to Grand Forks. An original application filed several months ago was complicated by a later application filed by Northern Natural Gas Co., to serve the same area.

• **Northern Indiana Fuel & Light Co.**—35 miles, 8-in., planned, Edgerton to Auburn, Ind.

Northern Natural Gas Co.—Company has just recently finished a large summer expansion. Still planned are:

170 miles of 20-24-in. line in Minnesota and Wisconsin running to Duluth and Superior.

400 miles of 24-in. line from the Canadian border to tie in with its system at St. Paul-Minneapolis.

500 miles of 24 or 30-in. planned across North Dakota from Tioga past Minot to Fargo and from there eastward to the Twin Cities.

• **Northwest Alabama Gas District.**—40 miles, 9-in., proposed, Southern Natural's line through Winfield to Haleyville, Ala.

• **Pacific Northwest Pipeline Corp.**—1,466 miles, proposed, Ignacio, Colo., to Bellingham, Wash. Approved by FPC.

Pipeline Patrol

380 miles, proposed, laterals and spurs off main line to Pocatello, Idaho, to Yakima, Wash.

• **Pine Tree Natural Gas Co.**—204 miles of undetermined size pipe to run from the Boston area to Bangor, Me.

• **Shenandoah Gas Co.**—40 miles, 3-4-8-in., proposed, Middleton, Va., to Martinsburg, W. Va. Est. cost: $1,470,000. FPC approved.

• **South Georgia Natural Gas Co.**—368 miles, 2-12-in., planned, Phenix City, Ala., to Tallahassee, Fla. (a) 12-in., Phenix City, Ala., to Albany, Ga., (b) 10-in., Albany, Ga., to Moultrie, Ga., (c) 8-in., Moultrie, Ga., to Tallahassee. Est. cost: $9,000,000. FPC approved.

• **Southwest Alabama Gas District.**—150 miles, 10 and 8-in., planned, Phenix City to Dothan, Ala. Engineering Const. Co.

• **Tennessee Gas Transmission Co.**—Company has FPC authority to build 243-mile, 24-in. line from Hebron storage field in Potter County, Pennsylvania, to existing facilities near Greenwich, Conn. Company will also build an 18-mile connecting line between Hebron storage field and Harrison storage field.

Tennessee Gas Transmission Co.—Houston Contracting Co. has contract for 57 miles of 20-in. natural-gas line from Kinder, La., to near Pecan Island, La. F. A. Silar is superintendent of the 30-mile stretch from Kinder to Intracoastal Canal, and E. C. Norris is superintendent on the remaining 27 miles.

Company seeks F.P.C.'s approval for a 370-mile 30-in. line from Agua Dulce, Tex. to Kinder, La.

• **Texas Eastern Transmission Corp.**—Proposed, 382-mile, 24-in. line from Kosciusko, Miss., to Beaumont, to connect with the existing 30-in. line there to Connellsville and replace the "Little Inch" in moving natural gas. The project will cost $71,000,000.

• **Texas Gas Corp.**—This firm will spend $3,500,000 on a line from Orange, Tex., to a connection with a new line of Transcontinental Gas Pipe Line Corp. in Cameron Parish, Louisiana. The project will call for crossing the Sabine River, building a compressor station, and a measurement station.

Texas Gas Transmission Corp.—Company has applied to F.P.C. for permission to build 207 miles of line along its system from Louisiana to Indiana.

• **Transcontinental Gas Pipe Line Corp.**—Company has plans for 315 miles of 36-in., 231 miles of 30-in., 23 miles of 16-in., 23 miles of 12-in. from Trenton to Woodbury, N. J. 12 miles of 24-in. to connect with Tennessee Gas Transmission's system in New Jersey. The program will loop parts of Transco's present system and will cost $80,000,000. 173 miles of the 30 and 36-in. and the 58 miles of the 12 and 16-in. lines have already received FPC approval.

• **Utah Natural Gas Co.**—Planning 40 miles from Orem to Salt Lake City, 16-in. pipe at later date. Contract not yet let.

Virginia Natural Gas Co.—153 miles, Buckingham to Richmond and Portsmouth, Va.

Foreign Crude-Oil Pipelines

• **Atlas-Dresser.**—Included in this company's agreement with the Argentine Government are plans to build a 400-mile, 16-in. crude line from Plaza Huincul area to Bahio Blanca.

Bombay Port Trust.—50 miles, 8 to 24-in., contracted, Bombay, India, to serve Standard Vacuum Oil Co., and Burmah Shell refineries. Merritt, Chapman & Scott Corp., contractors. (Crude and Products). Collins Const. Co. has subbed 84,000 ft. of Subaqueous work. Shutdown for Monsoon season during summer. Work was resumed September 15.

Compania Shell De Venezuela.—Company will build a pipeline from its Block I field off the western shore of Lake Maracaibo to its terminal at Palmarejo. The line will be known as "Lapline" and will run 18 miles in the lake and 27 miles on land. The underwater section will be 16-in., and the remainder will be 24-in.

Peace River Oil Pipe Line Co., Ltd.—Company plans to build a 16-in. line connecting Sturgeon, South Sturgeon, and Little Smoky fields in Alberta to a planned 106-mile, 12-in. line which would move the crude south to Trans Mountain Pipe Line Co.'s Edson, Alta., station.

• **Petroleos Mexicanos.**—145 miles, 12-in. considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Isthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

72 miles, 12-in., proposed, Poza Rica to Atzacapotzalco, Mexico.

Texas Petroleum Co.—Contract has been let to Foster Wheeler Corp. and Panama-Williams for a 119-mile, 12-in. crude line to move oil from Velasquez field in Colombia to a connection with the main Andian National system at Galan. Est. cost: $6,000,000.

• **Yacimientos Petroliferos Fiscales Bolivianos.**—170 miles, 4-in., planned, Bermejo to Tupiza, Boliva.

Yacimientos Petroliferos Fiscales Bolivianos.—Bolivian Government oil organization has awarded contract to Williams Brothers Sudamericana, Ltd., to construct a 6-in. crude line from Camiri field to Yacuiba on the Argentine border. The project will cost approximately $2,500,000.

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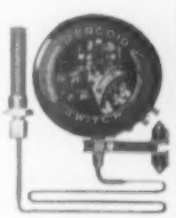

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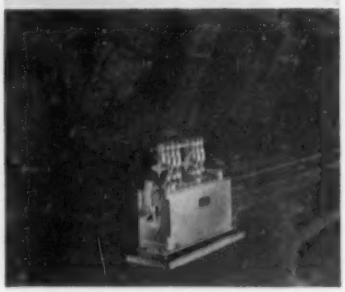

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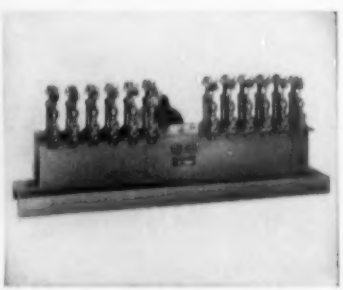

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Pipeline Patrol

Foreign Products Pipelines

• **Empresa Nacional del Petroleo.** — 80 miles, 6⅝-in., planned, Concon to Santiago, Chile.

• **Governments of South Rhodesia and Portuguese East Africa.**—200 miles, considered, Beria, Portuguese Mozambique to Umtalia, Southern Rhodesia.

• **National Fuel Oil Co.**—This company in Israel is a shareholder in a company which plans to build a products line between Haifa and Tel Aviv. The plans call for a 55-mile, 6-in. line in which the Government would own 10 per cent.

• **North Atlantic Treaty Organization (NATO).**—This defense organization is building products lines to airforce bases in various parts of France. Approximately 2,000 miles of 4-10-in. line will be laid.

Oleoducto del Pacifico, S. A.—Company is building 100-mile, 6- and 8-in. products line from Buena Ventura to Cali, Colombia. Pipeline Engineering Co. of Dallas, Tex., has the contract.

Overland Pipeline Corp.—This South African firm has requested government permission to build a 350-mile line, to cost $8,450,000, from the South African coast to Rand, a plateau area in southern Transvaal where there is heavy petroleum consumption.

• **Petroleos Mexicanos.**—124 miles, 6-in., planned, Lagos to Guadalajara, Mexico.

54 miles, 6-in. planned, Lagos to Aguascalientes, Mexico.

82 miles, 8-in., planned, Salamanca to Lagos, Mexico.

• **United States Government.**—375 miles, 12-in., planned, St. Nazaire to Melun and Metz, France.

• **United States Navy Department.**—Proposed 300-500-mile line to be built in Spain to serve a proposed naval base and four large air bases which are also proposed under a defense agreement with the Spanish Government. No definite size or cost is known now.

Winnipeg & Central Gas Co.—Canadian company plans to build a $20 million butane-propane system. Company plans to get gas L.P.G. from Signal Oil & Gas Co.'s Tioga, N. D., plant and move it to Winnipeg. Size and route of the line has not been definitely established.

Foreign Natural-Gas Pipelines

Alberta Gas Trunk Line, Ltd.—This Canadian firm has let engineering contracts to two firms, Dutton, Williams Brothers, Ltd., and Mannix, Ltd., for a 300-mile, big inch gas-gathering system to collect Alberta's natural gas for transportation to Trans Canada Pipe Line Co.

Attock Oil Co.—Company plans to build 60-mile natural gas pipeline from Dhulian field to Rawalpindi in West Pakistan.

• **Empresa Nacional del Petroleo.**—80 miles, 10-in., planned, Concon to Santiago, Chile.

Petroleos Mexicanos. — 205 miles 16-in. under way, Monterrey to Torreon, Mexico.

• **Petroleos Mexicanos.**—440 miles, 20-in., planned, Brazil to Tampico to Poza Rica, Mexico.

Sui Gas Transmission Co., Ltd.—Morrison-Knudsen Construction Co. has contract to build 350-mile, 16-in. line from Sui field to Karachi in West Pakistan. Est. cost: $25,000,000.

• **Trans-Canada Pipe Lines, Ltd.**—Company planning 2,250 miles of 24-34-in. natural-gas line from the Alberta-Saskatchewan boundary to Toronto and Montreal. Also plans a 24-in. lateral from Winnipeg to Emerson, Man. Twenty-inch lateral from Niagara to Toronto now in operation.

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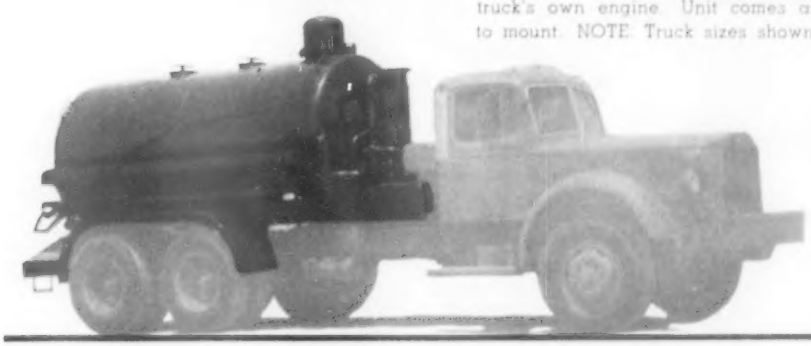
Model ST is available in 7 sizes. The 30, 35, and 40 bbl. units fit a 2-axle truck with 153" wheelbase and 84" CA; the 45, 50, 55, and 60 bbl. sizes fit a 3-axle truck with 175" wheelbase and 102" CA. (55 and 60 bbl. units are for off-highway use.) Power-pump take-off is from truck's own engine. Unit comes as 4-pc. kit, takes less than a day to mount. NOTE: Truck sizes shown are approximate.



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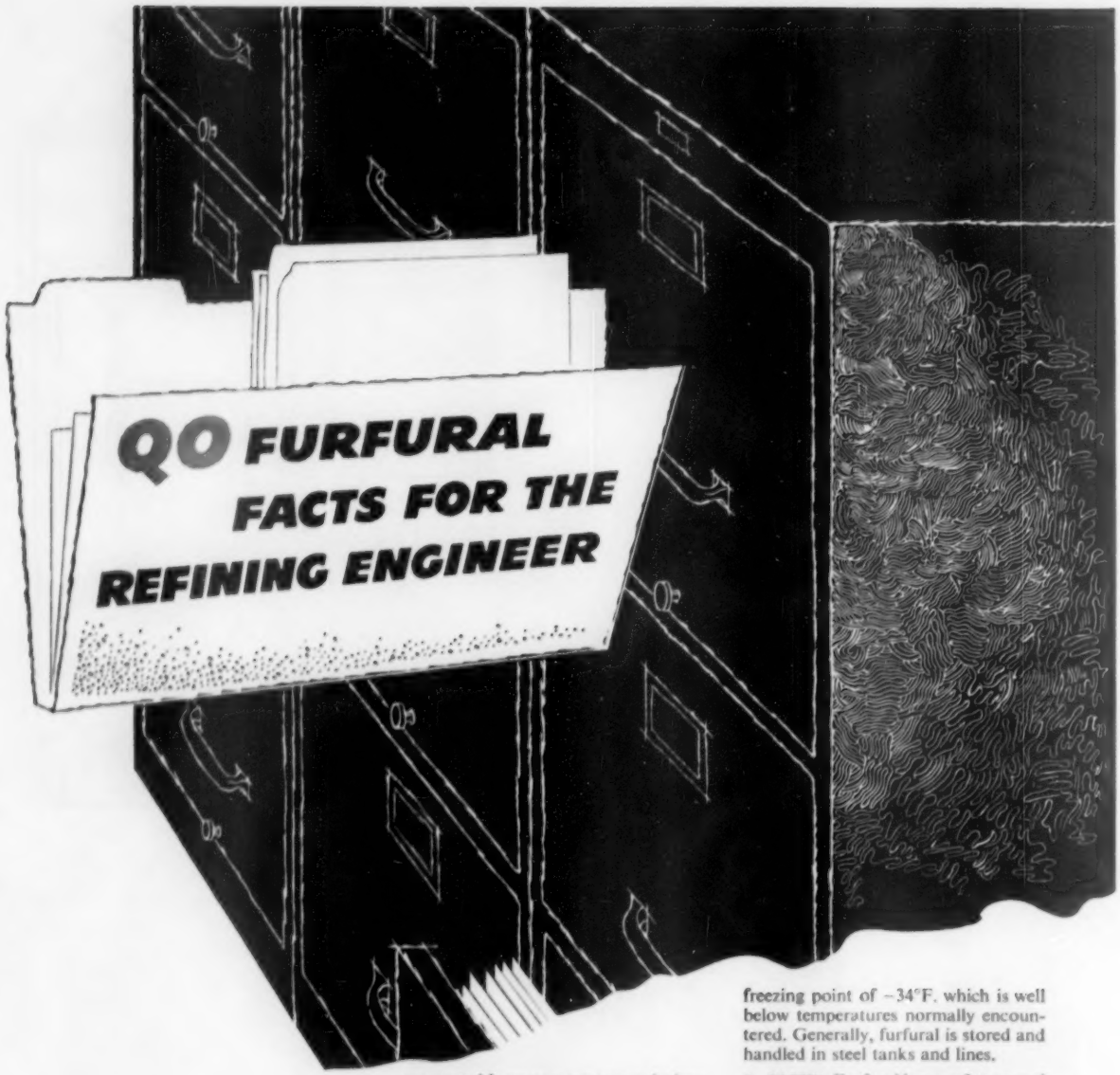

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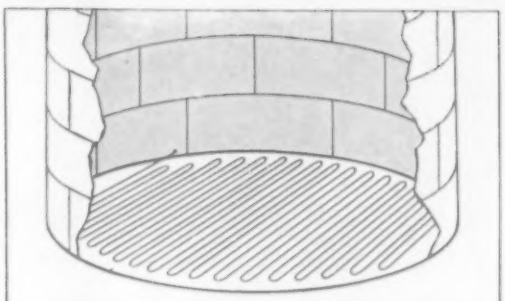
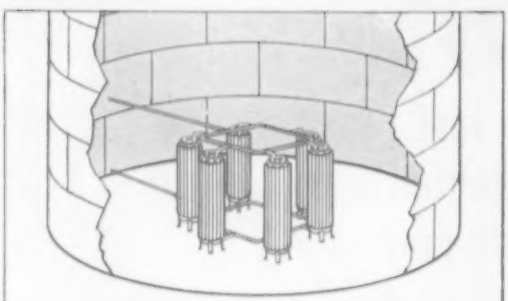
BETTER DESIGN MEANS BETTER PERFORMANCE



• Old-fashioned coils on the bottom of the tank are expensive to install. The pipes are soon covered over with sediment which seriously restricts the transfer of heat from the pipes to the tank liquid. The tank bottom is cluttered and difficult to clean.



• Our TF-18 Tank Heaters mount vertically. Sediment can not settle on the heat transfer surfaces. Heaters are entirely surrounded by tank liquid, assuring highly efficient heating of stored products year after year. Tank bottom is uncluttered, easy to clean.

Vertical Mounting

of BROWN FINTUBE TF-18 TANK HEATERS

assures more efficient, less costly heating of stored products

Our TF-18 vertically mounted tank heaters have obsoleted old-fashioned tank coils — and give users four outstanding advantages:—

1) **Lower Cost**—Users report that the cost of our TF-18 Heaters ***plus*** their installation is usually ***less than the cost of just installing*** bare pipe coils of equivalent capacity.

2) **Vertical Mounting** — on legs about 10" above the tank floor brings the entire heating surface in contact with the stored product — avoids heating through a layer of sediment.

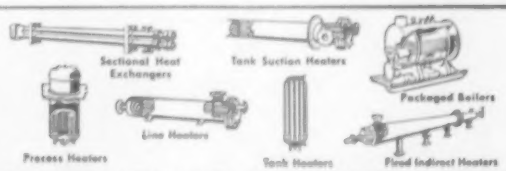
3) **Increased Heating Efficiency** — the finned construction provides about 7 times more heating surface per foot of lineal length than plain bare pipe. This permits more heat to be transferred — faster — at lower temperatures per square foot of surface, avoiding coking or damage to heat sensitive products. Mild steel or alloy construction.

4) **Easy Installation** — TF-18 Heaters pass through a standard manhole permitting easy installation in new or existing tanks. Can be flange connected when desired and thus do not require welding inside the tank. Individually trapped, or manifolded inside or outside the tank.

You can't keep your operations competitive with old-fashioned, obsolete methods. Write today for Bulletin 541. It gives full details, dimensions, etc., about our fully proved, less costly TF-18 Heaters. Tested, and widely used by many of the best known, most progressive, lowest cost companies in the industry. Write for Bul. No. 541 ***today!***

BROWN FINTUBE CO.

365 HURON ST., *Elyria, Ohio*



Engineering and Sales Representatives: NEW YORK • BOSTON • PHILADELPHIA • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI DETROIT • CHICAGO • ST. PAUL • ST. LOUIS • KANSAS CITY • MEMPHIS • BIRMINGHAM • NEW ORLEANS • SHREVEPORT • TULSA • HOUSTON • DALLAS DENVER • LOS ANGELES AND SAN FRANCISCO ● *Licensed Manufacturers:* BROWN FINTUBE (CANADA) LTD., ST. THOMAS, ONTARIO, CANADA BROWN FINTUBE (GREAT BRITAIN) LTD., BIRMINGHAM, ENGLAND • FRIEDRICH UHDE, GMBH, DORTMUND, GERMANY

Our 125 "dry holes"

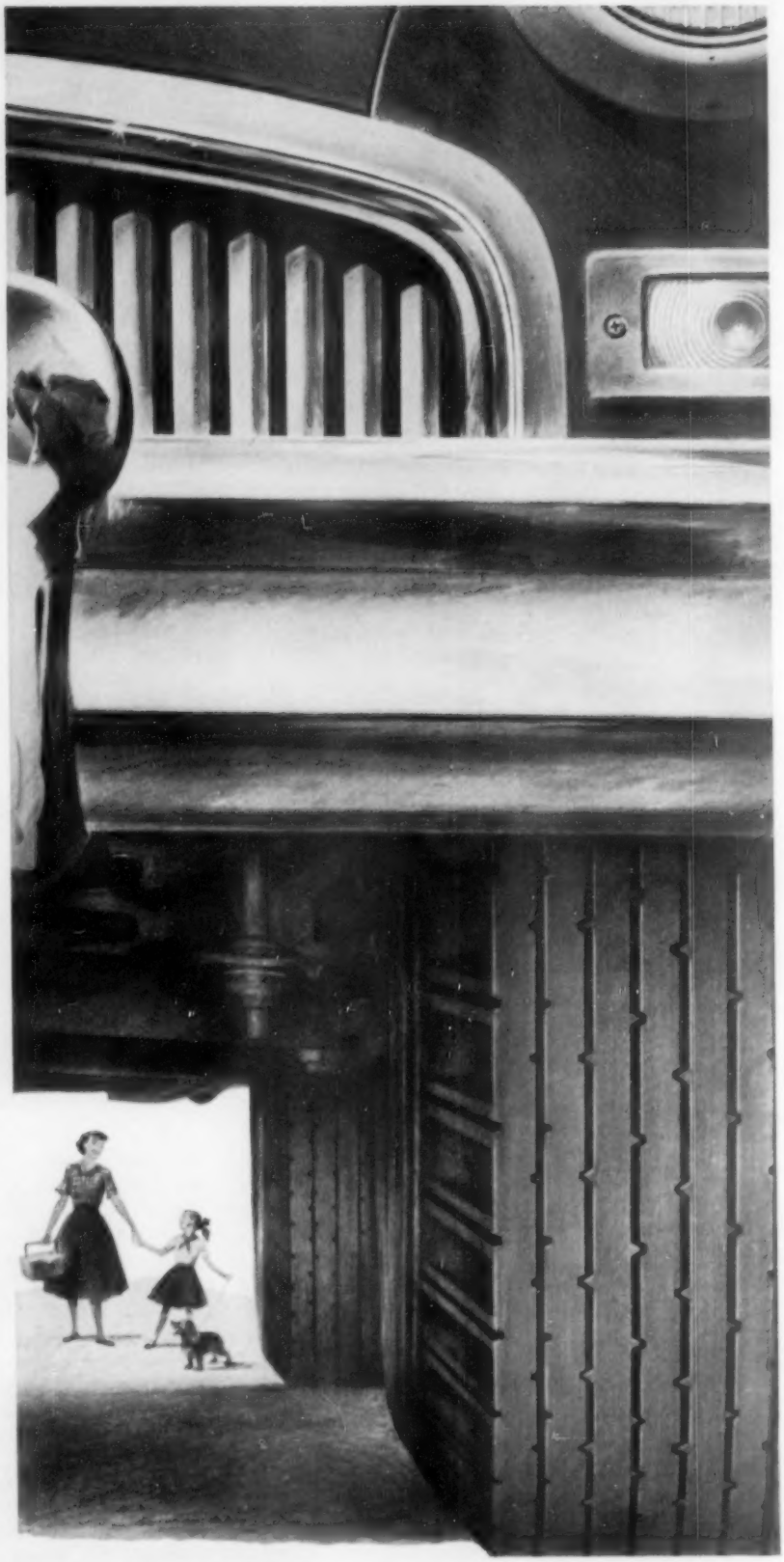
last year helped keep you on wheels

If you're anything like the average motorist, you'll need about 690 gallons of gasoline to take you where you want to drive this year. And that's just a beginning. Keeping you on wheels and supplying you with the thousand and one "oil-born" products so vital to modern living requires 2 gallons of petroleum a day for every man, woman and child in the U.S. — an increase of 58% since 1941.

Helping to keep this oil flowing to you is Standard Oil Company of California's biggest, most expensive, least predictable job. In fact, we plan to inveat $200 million during 1955 alone in exploring for new oil fields and developing existing ones, to help replace the petroleum you'll use.

Some 700 times during the year, Standard drillers will start bits spinning. As much as 16,000 feet of pipe may follow the bit before oil is found or the well is abandoned. Either way it's a costly hole: drilling an oil well may run anywhere from $125,000 to over $1 million. And every one is a risk—only 1 out of every 9 wells drilled in the United States in a promising but unproven area ever turns out to be an oil producer.

Yet new sources of oil must be found to keep our nation's abundant supplies from dwindling. Risking "dry holes" is the only way to find them. So the 125 "dry holes" we drilled last year are good evidence of the job Standard does to help keep you on wheels.



STANDARD OIL COMPANY OF CALIFORNIA *plans ahead to serve you better*

A STEEL STOP VALVE on which YOU CAN STANDARDIZE

DELIVERIES FROM STOCK

It's no longer necessary to buy a different type of forged steel stop valve for every different service. Here's a valve on which you can standardize—one that fits 90 per cent of normal services where forged steel stop valves are used.

Built in globe and angle designs, from $\frac{1}{4}$ in. to 2 in. sizes, with screwed or socket welding ends. Deliveries can ordinarily be made from factory stocks.

Fig. 2698—Globe, inside screw, 600 lb sp.

Fig. 2699—Angle, inside screw, 600 lb sp.

Similar design, O.S.&Y. type, also carried in stock.

For design and dimensional details on these and other Edward steel valves, write for Catalog No. 105.

These Features Save you Money!

1. Low Pressure Drop — You can use smaller pipe sizes.
2. EValloy Stainless Steel Seats and Disks Borized in Mated Pairs.
3. EValized Bonnet—Wear Resistant Threads.
4. Centerless Ground Stem—Long packing life.
5. Easy Packing Adjustment.
6. Oversize Handwheel—Easy Operation.
7. Forged Steel Bodies and Bonnets.

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1212 W. 145th STREET

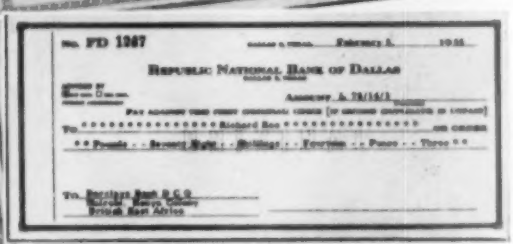
EAST CHICAGO, INDIANA

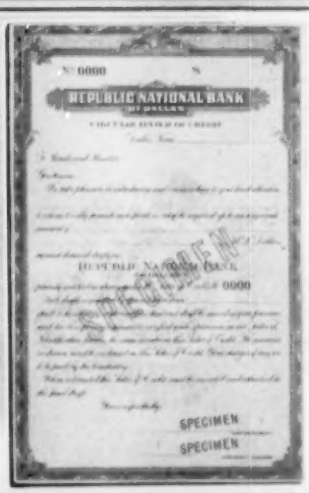
Known and Recognized throughout the World!..

From Buenos Aires to New Delhi — from Tokyo to Rome, the Foreign Department at Republic maintains direct connections with principal banks throughout the world.

That's why a Republic draft drawn payable in foreign currency or a Republic Letter of Credit is as good as cash — and sometimes better.

Your export, import and foreign exchange financing are in capable and willing hands at Republic.





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NATIONAL BANK of Dallas

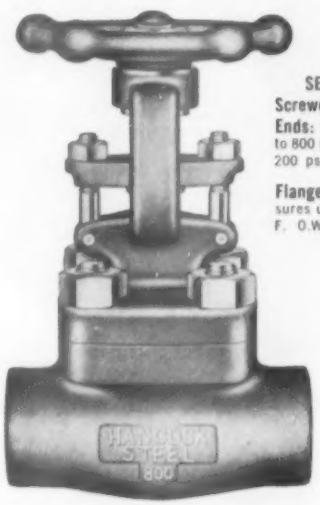
MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

The Financial Center of the Southwest

LET US SHOW YOU WHY

Hancock Steel Gate Valves set the pace in dollar-for-dollar service and value

TYPE 950 HANCOCK 800# STEEL GATE VALVES
Outside Screw and Yoke. Sizes: ¼" thru 2"



SERVICE RATINGS
Screwed and Socket Weld Ends: For all pressures up to 800 psi. at 775° F. O.W.G. 200 psi.—100° F.

Flanged Ends: For all pressures up to 800 psi. at 775° F. O.W.G. 1440 psi.—100°F.

Install a Hancock 800# Bolted Bonnet Steel Gate Valve in your piping system and prove for yourself why this valve sets the pace in dollar-for-dollar service and value. Hancock Gate Valves have cut valve costs in hundreds of refineries, chemical and petrochemical plants and other installations . . . have proved themselves the best, most economical valve for process and power piping systems. They can mean similar savings for you.

To provide such service and value, Hancock Gate Valves combine two big advantages: specially selected materials for extraordinary long wear under difficult operating conditions and an exclusive design for positive, maintenance-free performance. Features include highly accurate guiding to prevent wedge dragging and consequent leaking, a wedge of "500 Brinell" stainless steel, seat of 11-13% chrome stainless steel, plus a spiral-wound gasket and swing bolt and nuts of stainless steel.

When Hancocks go in, valve costs go down.

GET THE WHOLE STORY about these 800# Hancock Steel Gate Valves from your local Industrial Supply Distributor. His knowledge of valves and their correct application can also save you time and money. Phone him today.

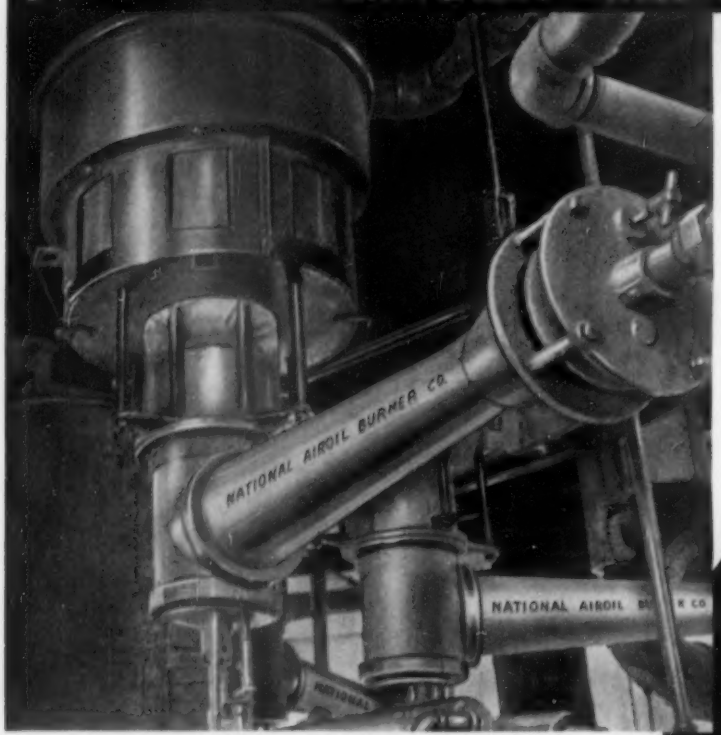
In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.

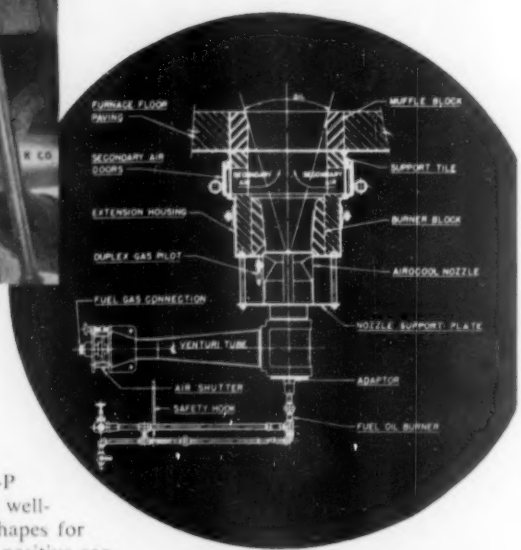
Designed for VERTICALLY FIRED PETROLEUM HEATERS



NATIONAL AIROIL

VERTICAL

Oil-Gas Tandem Combustion Units



many more hours on stream, without forced shutdown

Exclusively for vertical firing, National Airoil VERTICAL C-P Tandem Block Units retain all the features of our regular well-known Tandem Units . . . plus: special pre-cast refractory shapes for easier installation and maintenance; secondary air louvres for positive control of flame pattern; and an all steel duplex detaching gear which enables swift, easy, oil burner removal.

VERTICAL C-P Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Blocks allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

ALL VERTICAL Tandem Units are fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . have a high turn down ratio with steady flames . . . maintain high flame temperatures using either fuel oil or gas. With the C-P TANDEM UNIT's clean flame, a cold furnace can be brought to full capacity in a shorter time.

"Many, many more hours on stream, without forced shutdown" . . . yes, YOU will realize high profits from YOUR heaters when National Airoil C-P VERTICAL Tandem Units are specified. Our new folder 498 is yours for the asking.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

Main Office & Factory: **1236 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**
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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

CUSTOM BUILDING

...the Autocar Feature of Most Benefit to You

Your toughest hauls become easy when you use Autocars, because Autocars are custom-built to meet them. We help you select the proper components for your Autocar . . . the engine, frame, transmission, rear, etc., which will function best for you. A truck built under this system performs on an entirely different plane. Its useful life will be longer, its maintenance will cost less, and you will have to look twice at the figures before you will believe its ton-mile hauling efficiency.

Your Autocar starts down the assembly line with a tag specifying exactly the components recommended for your hauling conditions.

AUTOCAR TRUCKS

AUTOCAR DIVISION OF THE WHITE MOTOR COMPANY, EXTON, PA.

Autocar trucks are sold and serviced throughout the world

Send for the Autocar Fact Booklet. It tells you about custom building and many other exclusive Autocar features.

Autocar Division of The White Motor Company, Exton, Pa.
Please send me the Autocar Fact Booklet.

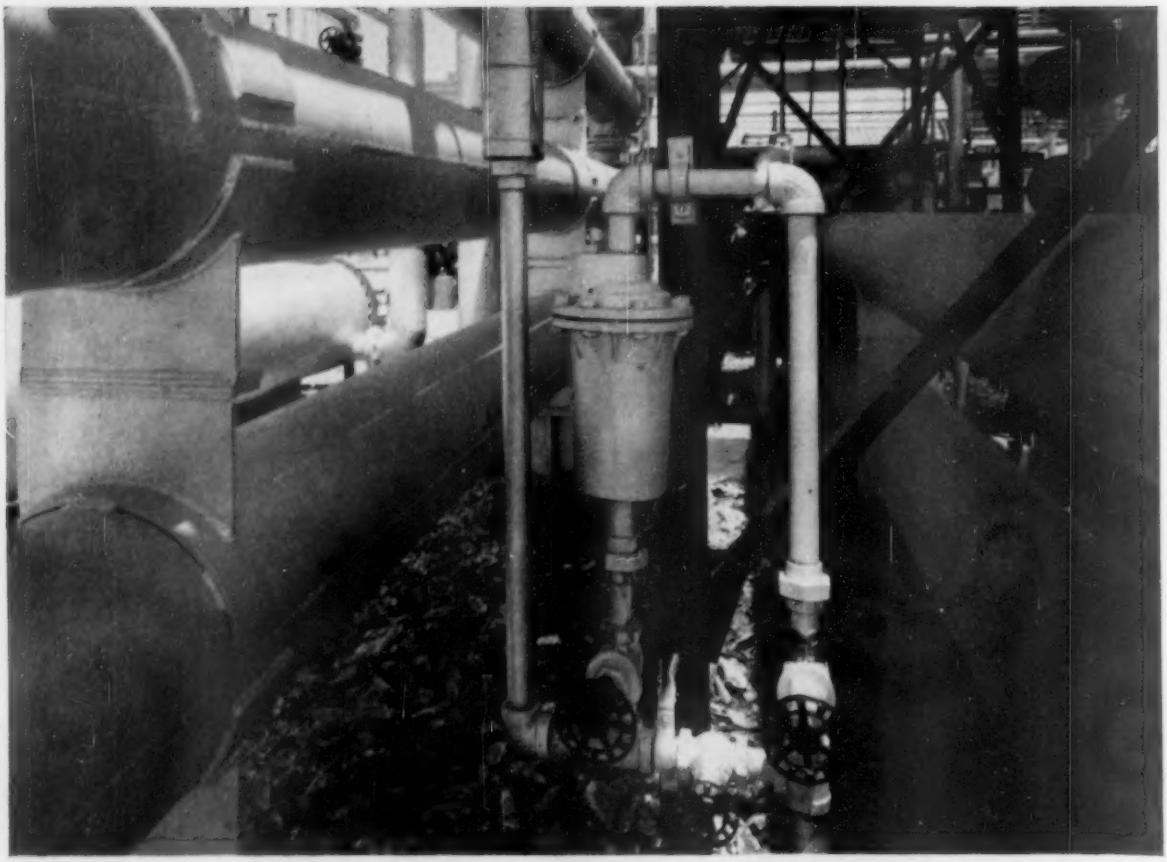
Name and Title_____

Firm Name_____

Address_____

Type of Operation_____ No. of trucks in fleet_____

19-C



A Trap Designed to Make the P. A. Happy*

P. A. States The Case. The Purchasing Director of a midwestern refinery says: *"The lowest price bid is sometimes not the most economical or desirable one. Often a proper evaluation of other factors reveals quite the contrary to be the case. What we are after is to obtain the lowest overall cost of operating units. Therefore, the first cost of any piece of equipment must be considered together with such other factors as maintenance, safety, durability, flexibility, etc."*

*On the above basis Armstrong traps are certainly designed to please the Purchasing Agent as well as the Superintendents, Engineers, Steamfitters and Maintenance Men:

Installation. Armstrong offers side inlet-side outlet or bottom inlet-top outlet traps in sizes up to 1¼" so hook-ups can be made with minimum labor and fittings. All traps can be equipped with internal check valves, and the three smallest sizes are available with integral strainers. These optional built-in features mean lower installation costs.

Durability. Valves and seats are file-hard chrome steel, ground and lapped together. The other parts are corrosion-resistant stainless steel. Mechanisms in low and medium pressure traps are identical in design, materials and workmanship to those used in traps for 900°F, 900 psig!

Maintenance. Armstrong traps seldom require maintenance. And, they are easily inspected or repaired simply by removing the cap to which the entire mechanism is connected. The body stays in the line. To make a trap new again, simply install a repair assembly straight from the factory production line.

Safety. Every fine-grained cast semi-steel trap is factory-tested at 500 W. S. P. For great resistance to fire, shock and explosion Armstrong offers a complete line of forged steel traps starting at only $20.00 list.

For lowest cost in the long run, Armstrong traps are your best buy. Call your nearby Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
868 Maple Street, Three Rivers, Michigan

Application Engineered

ARMSTRONG STEAM TRAPS

ASK FOR CATALOG J
44-pages of trapping facts and figures, how-to-do-it data and useful information. Free on request.

565

How oil field operators can take full advantage of Allis-Chalmers Dealer Service Plan to help protect profits

BENEFITS: Better performance • More time on the job • Longer equipment life • Lower maintenance cost • Higher resale value

Experience has convinced many oil field operators that the Allis-Chalmers Dealer Service Plan is geared to keeping equipment operating efficiently. They have found that taking full advantage of such service is easy, and that it pays big dividends. Here's why:

Allis-Chalmers dealers offer them a *planned* approach to service, right from the day their equipment is delivered. It covers everything from service schools to lubrication schedules, and from parts to preventive maintenance.

You owe it to yourself to take a look at the advantages this service plan offers. Then see your nearby Allis-Chalmers dealer soon and ask him to give you all the facts.

PREVENTIVE MAINTENANCE TRAINING KITS — movies, slides, charts and literature — are available for helping you train your own personnel. Your Allis-Chalmers dealer will present it for you at your convenience or arrange to have a factory man do the job.

FAST PARTS SERVICE. Factory-built Allis-Chalmers parts are stocked in quantities by the *dealer*, to give you parts service close to your job. Experienced equipment men agree it pays to use only standard factory-built parts.

SCHEDULED CHECKUP PROGRAM — Your Allis-Chalmers dealer will help you plan a schedule for all maintenance work. You'll save excessive repair bills, avoid costly downtime and get far better performance, longer life from your machines.

OPERATING TIPS — Allis-Chalmers dealer servicemen are trained to give your operators all the facts they need to operate equipment most productively — for example, how to recognize when adjustments should be made.

SPECIALIZED FACILITIES at your Allis-Chalmers dealer include factory-approved tools and all necessary service equipment. Factory-approved methods are used to save you time and money, assure finest workmanship.

FACTORY-TRAINED DEALER SERVICEMEN have the specialized experience to help you spot trouble symptoms fast, help you prevent costly breakdowns. Their training never stops: they make it a *policy* to stay abreast of every development.

FACTORY SERVICE SCHOOL TRAINING is open to your operators and servicemen just as it is for Allis-Chalmers dealers. Your men discover that Allis-Chalmers design simplicity makes the equipment easy to learn . . . easiest of all to service.

ALLIS-CHALMERS

TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

HOW'S THIS FOR OS&D HOSE PERFORMANCE?

Tanker loading conditions are particularly severe at the Union Oil Company's Port San Luis Wharf, Avila, California. When heavy seas are running, tankers must be held some 75' to 100' away from the dock with the aid of four heavy mooring buoys plus the ship's anchor. In spite of these conditions, Hewitt-Robins Smooth Bore Oil Suction & Discharge Hose performs with maximum efficiency.

Normal life expectancy for loading hose at this installation is 15,000,000 barrels, yet a single line of Hewitt-Robins Smooth Bore OS&D Hose has handled over 37,000,000 barrels to date. Here again, a customer's performance record has shown that for longer hose life and more economy in operation the first and best choice is Hewitt-Robins Hose.

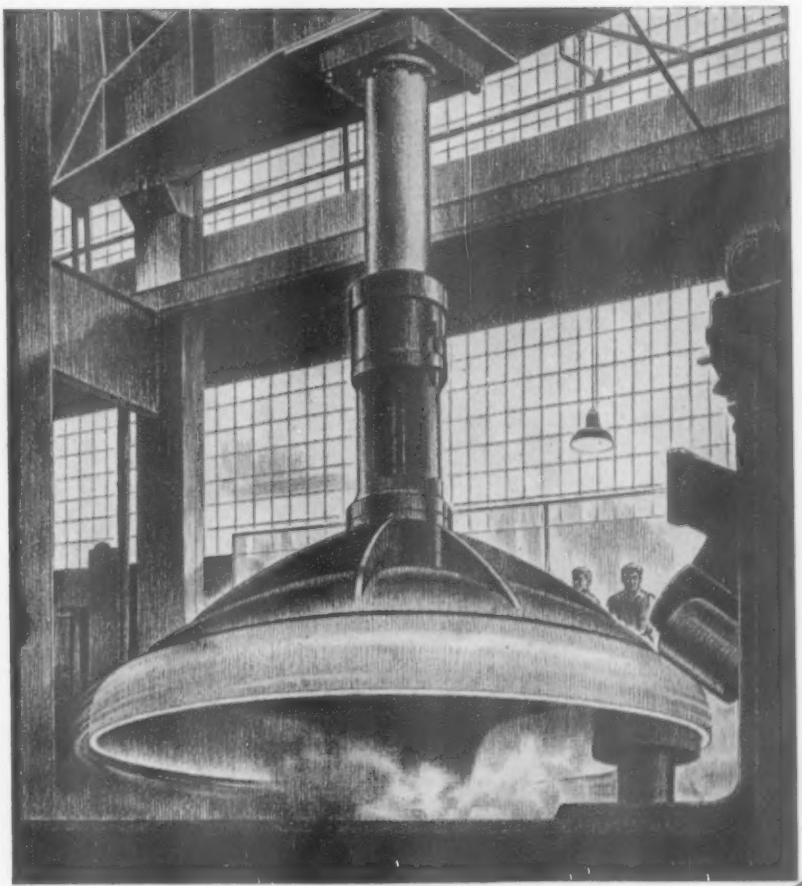
For immediate information regarding Hewitt-Robins OS&D Hose or any *Hewitt-Robins industrial hose contact your local Hewitt Rubber Distributor (See "Rubber Products" Classified Phone Book.)*

Hewitt-Robins

Conveyor Belting—Conveyor Machinery—Industrial Hose—Vibrating Screens—Vibrating Conveyors—Design, Manufacture, Engineering and Erection of Complete Bulk Materials Handling Systems.

HEWITT-ROBINS INCORPORATED • STAMFORD, CONNECTICUT

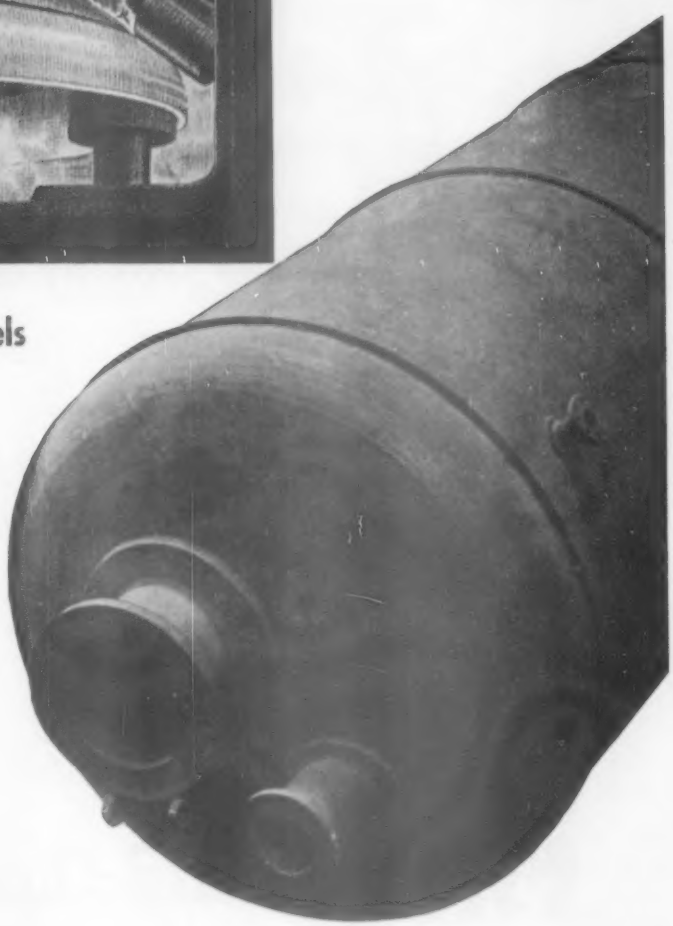
Spinning



SAVES METAL

—CUTS TOOL COSTS

The design and production of Pressure Vessels may be greatly facilitated by using dished and flanged ends spun by Harveys on the Rotarpress. They combine semi-ellipsoidal form with large knuckle radius. A substantial reduction in plate thickness can be effected, and in most cases tool costs are eliminated.



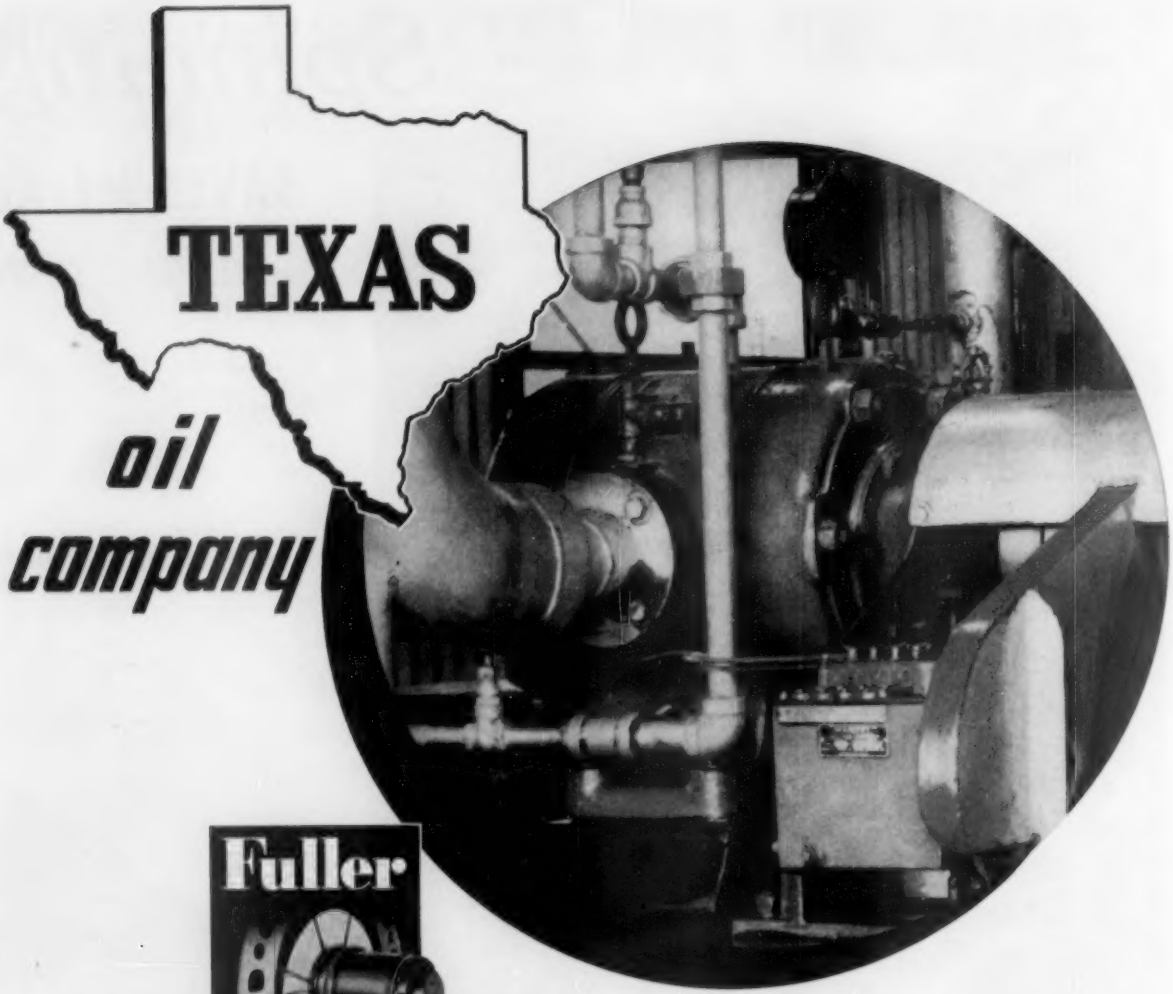
'Rotarprest' Ends for Pressure Vessels

can be supplied in Mild, Alloy and Clad Steels and Non-Ferrous Metals. The capacity of the Rotarpress ranges from 5 to 15 feet diameter, and ⅜" to 4" thickness. Knuckle radii and depth may be varied to meet individual requirements.

Please ask for List No. OG-881 giving full range of sizes.

Harvey

G. A. HARVEY & CO. (LONDON) LTD.
WOOLWICH ROAD, LONDON, S.E.7
ENGLAND
Cables: "Chesper, London"



USES Fuller *ROTARY COMPRESSORS*

FOR SURE, PULSE-FREE SERVICE

Fuller Rotary Compressors hold many "key" jobs in the petroleum industry. Illustrated is a Fuller Rotary Single-stage gasoline-vapor booster in a gasoline plant in the Texas Panhandle. This machine has a capacity of 173 c.f.m., referred to intake condition of 75-lb. gage, (1055 free c.f.m.) compressing to 175-lb. gage discharge, operating at 1000 r.p.m.

Fuller Rotary Compressors in the refinery for general plant air, purging gas, and handling butane-butylene, as well as in the field for pressure boosting and gas gathering, have proved their worth, as is evidenced by the many machines in daily use in practically every oil-producing section of the country.

Simplicity of construction has proved to be one of the important factors . . . the only moving parts being the rotor, bearings, and blades. No valves to leak, no seats to grind, results in maintained capacity for the life of the machine. A simplified direct drive eliminates power transmission losses. For further information, write to Fuller Company, Catasauqua, Pennsylvania.

Fuller *Pioneers of high-efficiency rotary compressors*

C-246
2322

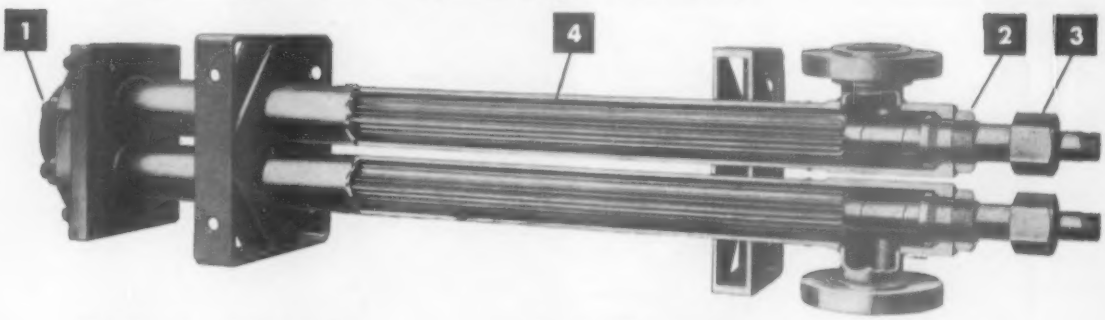
Positive Identification

Just as a person's fingerprints offer positive individual identification, so the design features of G-R Twin G-Fin Sections distinguish them from all other types of heat exchangers. They are positively G-R.

Simplest Head Closure

Easy Maintenance—Fewer Parts

This design provides greater ease of installation, as has been proved in the service of more than 70,000 G-R Twin G-Fin Sections on a greater variety of condensing, cooling, heating and heat exchange services than any other design on the market.



To Remove Element—

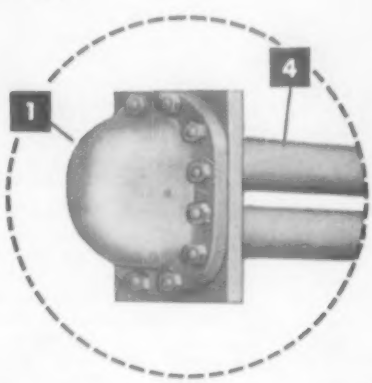
Take off shell cover (1)
Loosen and remove cone plug lock nut (2)
Loosen and remove union nut (3)
Remove element (4)

To Replace Element—

Insert element (4)
Replace and tighten cone plug lock nut (2)
Replace and tighten union nut (3)
Replace shell cover (1)

Domed Shell Cover

This type of shell cover is particularly rugged, yet weighs only 17 pounds for the small sections and 43 pounds for the standard high capacity sections.



THE GRISCOM-RUSSELL CO.

MASSILLON, OHIO

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

G-R HEAT TRANSFER APPARATUS Twin G-Fin Section

GR-330

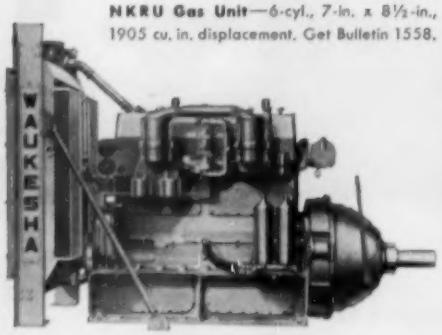
Severns Drilling Company of Southern California, are making more hole with their National drilling rig—recently repowered for them by the Frazier Wright Company of Los Angeles, with three Waukesha Gas Power Units — Model LRZBU, six cylinder, 9⅛-in. bore x 8½-in. stroke, 3520 cu. in. displacement (shown below, right).

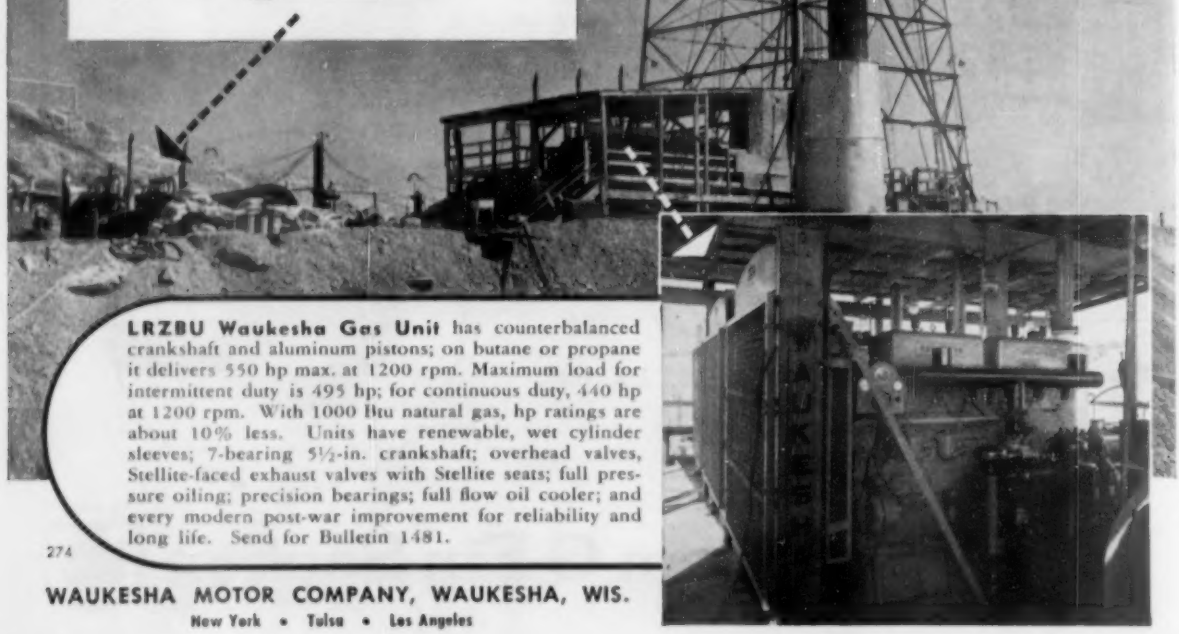
Send for Bulletin 1079 describing complete line of Waukesha Oil Field Engines for gas, gasoline, normal Diesel, or turbocharged Diesel operation—to 1135 hp.

World's Finest Oil Field Power
WAUKESHA

Still on the job after nine years' service are two Waukesha NK Series units, driving the standby mudpumps here. In all this time **neither engine has had the head or pan off!**

NKRU Gas Unit—6-cyl., 7-in. x 8½-in., 1905 cu. in. displacement. Get Bulletin 1558.





LRZBU Waukesha Gas Unit has counterbalanced crankshaft and aluminum pistons; on butane or propane it delivers 550 hp max. at 1200 rpm. Maximum load for intermittent duty is 495 hp; for continuous duty, 440 hp at 1200 rpm. With 1000 Btu natural gas, hp ratings are about 10% less. Units have renewable, wet cylinder sleeves; 7-bearing 5½-in. crankshaft; overhead valves, Stellite-faced exhaust valves with Stellite seats; full pressure oiling; precision bearings; full flow oil cooler; and every modern post-war improvement for reliability and long life. Send for Bulletin 1481.

274

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

New York • Tulsa • Los Angeles

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. . . Use These Handy Time-Saver Cards

As you read through the pages of The Oil and Gas Journal and you see products advertised on which you would like more information,

Ask us to get it for you

Just use the convenient pre-stamped cards on this page. We'll forward your requests promptly.

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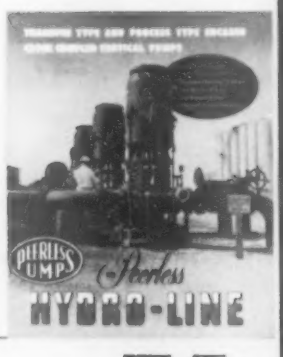

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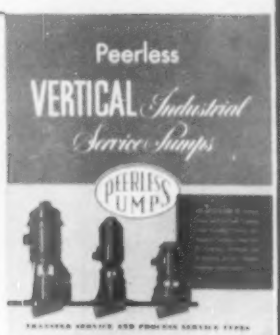

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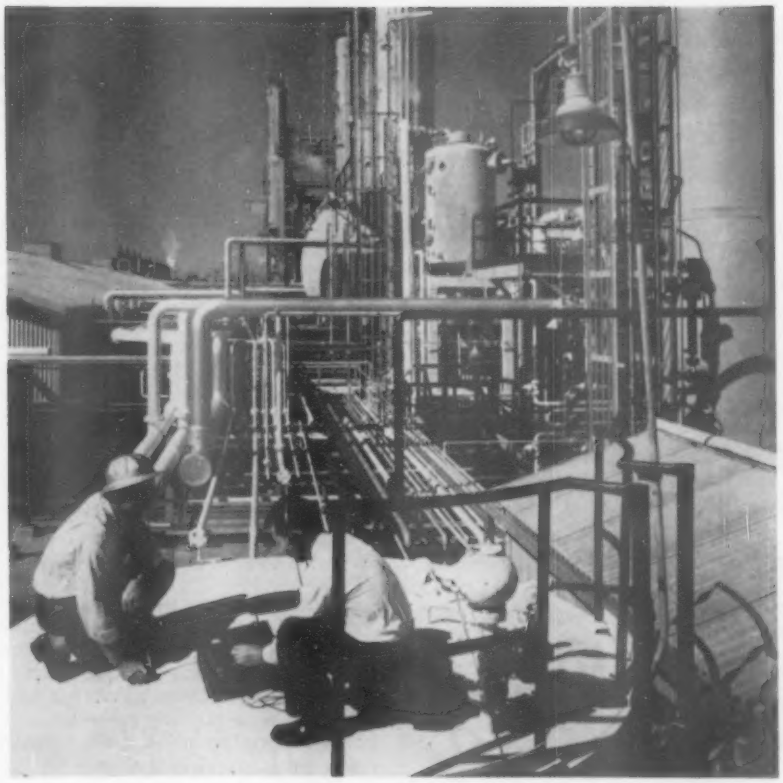

Adequate training and careful supervision are of utmost importance in applying the newer methods of inspection. Here at Shell Chemical Corp.'s Houston plant, vessel thickness is being determined by an Audigage. (Photo courtesy Engineering Test Service).

Reduce Unscheduled Shutdowns

. . . by intelligent use of nondestructive inspection methods

by T. C. Wilson

DURING the past few years, service requirements of refinery equipment have made it necessary to obtain material of high quality. This must not only be inspected for irregularities and defects at source of supply, but also periodically after being placed in service. Repairs that might be required must be closely controlled. Since it is not practical to test every piece of equipment used by metallographic examination or by physical means, industry has turned to the field of nondestructive testing.

Nondestructive tests . . . Visual inspection, mechanical calibration, pressure tests, hammer testing, corrosion buttons or bench marks, trepanning and drilling of test holes—these are nondestructive methods of inspection that have been used for years in the refinery. But these methods have their limitations. Therefore, there has been developed a class of nondestructive testing instruments for the examination and inspection of equipment that supplements these older methods.

Newer tests . . . Among these methods are radiography, supersonic instruments for determining thickness, magnetic-particle inspection for locating surface and subsurface defects, and fluorescent penetrants for detecting surface defects in magnetic as well as in nonmagnetic materials. Following are described some of the older and the newer methods of inspection. Such methods can be used to advantage in the refinery, to shorten inspection and offstream time, to reduce costs, and to increase the safety factor for both personnel and equipment.

Magnetic-Particle Inspection

Magnetic-particle inspection has been available since the middle '30's. But only in the past few years has it been utilized in making inspection in the refinery, in fabricating shops, and in the field fabrication of piping and pressure vessels.

Early experience with magnetic-particle inspection was acquired with the use of welding generators and homemade prods. Although there was a reasonable amount of success with this equipment, there were major hazards attending the use of it. Damage by highly localized burning of the surface when prods slipped, and the resultant arcing causing "flashes" or "burns" which could seriously damage the eyes of the operator, are examples of such hazards.

Weld inspections . . . Recently, four Sinclair refineries were equipped with Magnaflux units, that have been found to be the most suitable in the majority of refinery applications. These units provide the operator with a quick and reliable means of portably inspecting large vessels or tanks. They also supply sufficient magnetizing current to perform inspections up to 105 ft. from a unit, without any loss in inspection sensitivity. Magnetic-particle inspection should not be used to the exclusion of other types of inspection. Nor is it the final answer for weld inspection problems. But when used in conjunction with other forms, it will provide an additional assurance of sound welds.

Magnetic-particle inspection should not be expected to reveal ordinary porosity or isolated, small slag pockets, but it will reveal cracks, slag stringers, lack of fusion, and poor penetration, provided these elements do not lie too far below the surface. It will readily locate serious cracks that even radiography cannot find. It is especially useful for the inspection of welds in manways and nozzles or in pressure vessels and tanks. At such locations, the use of radiography is difficult and often impossible. The possibility of surface cracks occurring at such locations is much greater than in vessel seams.

Based on the results obtained by magnetic-particle inspection of weld seams in several field-erected vessels, and in a shop-fabricated vessel, it is felt that in some cases such inspection should be used to supplement radiography inspection. Therefore, magnetic-particle inspection has been included in the Sinclair general specifications for pressure vessels.

Training . . . Operators assigned to

magnetic-particle inspection should be adequately trained and carefully supervised. They should be given the opportunity of seeing all metal-repair operations in areas which they have inspected. In this way they may see exactly what caused the indications. It is also desirable for the operator to have a general knowledge of the process, so that he may appreciate its limitations.

Of great importance are design details, especially fillet welds. Here the use of direct current frequently discloses root openings and unfused root faces, which are characteristic of the design and are definitely intended by the designer. Root openings and unfused root faces are not disclosed with alternating current, regardless of current density employed, unless they are immediately below the surface.

In view of this, alternating current should be used preferably for the inspection of fillet welds in general. The disclosure of nonrelevant root openings has resulted in extensive chipping and rewelding operations at a high cost. This point is being brought out to emphasize the importance of selecting the proper means of magnetizing, in order to achieve a desired result.

THE AUTHOR

T. C. Wilson, assistant chief inspector, Sinclair Refining Co., joined Sinclair in 1922 in development and research work. Since 1930 has been engaged in inspection department of central engineering. He is a member of National Association of Corrosion Engineers and Society for Non-Destructive Testing, Inc.

Records . . . Permanent records of indications are possible with the use of scotch tape. Excess powder is blown carefully away or otherwise removed, and a strip of scotch tape is then laid over the indication and pressed down with gentle finger pressure, after which the tape is peeled off, bringing the indication with it. The strip may then be laid on white paper for photographing, placed on tracing paper for blue printing, or kept on the page of a notebook. Direct photography makes an excellent record of powder patterns, although it is somewhat slower and more costly.

Up to the present time, magnetic-particle inspection in the refinery has been confined to vessel plate and welds, pipe welds, furnace castings, high-pressure steam-turbine casings and rotors, pump casing and rotors, air-blower rotors, valves, crane hooks, shackles, lifting lugs, and sheave blocks. There are numerous other applications where this method of inspection can be used to advantage. A few of these are: (1) Detection of fatigue cracks in machinery parts, of cracks originating from caus-

The Reflectoscope, an ultrasonic instrument, is being used here to test a vessel shell. This instrument can be used for detection of flaws.

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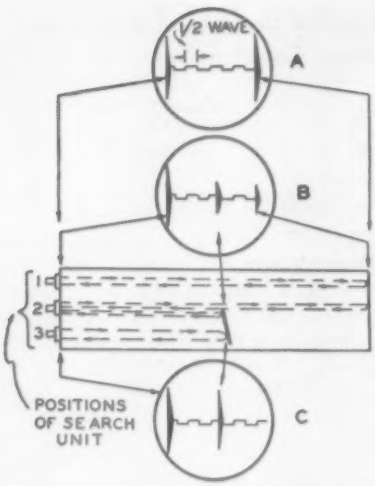


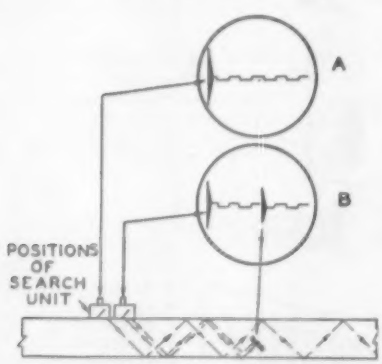
Determining flaw in long shaft by ultrasonics. "A" is cathode-ray pattern when no flaw is detected. "B" shows portion of beam intercepted by defect. "C" shows entire beam intercepted by defect.

tic embrittlement, or of stress corrosion cracks in riveted vessels, which develop between rivet holes and along calking edges of the plates, and (2) fissures in plates and heads, which have been subjected to attack by hydrogen, are readily located with the use of magnetic-particle inspection.

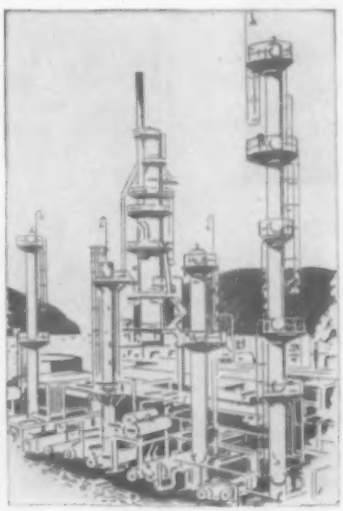
Preparation . . . Except for stringer bead reinforcement, no special preparations are made on new welds, aside from scraping off the slag and buffing. Most serious types of defects in welded seams are elongated in a direction parallel to the seam. Therefore, any surface irregularities similarly oriented will tend to mask any indication of a defect by mechanical entrapment of the powder. For this reason, where stringer beads have been left in the as-welded condition, it is usually necessary to grind the surface fairly even, in order to detect minute surface cracks. On welds of vessels that have been in service, buffing of outside welds is usually all that is necessary. However, welds on inside of vessel should be sandblasted.

On a recent field-erected pressure vessel, all weld seams (approximately 2,800 ft.) and all nozzle and manway welds were magnetic-particle inspected. In addition, 50 per cent of the weld seams were 100 per cent radiographed, and the remainder were random radiographed. Numerous cracks were found running from 1 to 11 in. in length and from $\frac{1}{8}$ to $\frac{5}{8}$ in. in depth. In many instances, magnetic-particle inspection readily located serious cracks that were not detected by radiography. After the defects were removed, welds were again Magnafluxed before any repairs were made.

Turnaround inspection . . . During a recent "turnaround" the main seams of a vessel that had been in operation approximately 5 years were inspected with Magnaflux, and defects, both surface and subsurface, were found running intermittently the entire length of the longitudinal seam. The depth of the surface cracks ranged from $\frac{1}{8}$ to $\frac{3}{8}$ in. and from 1 to 3 in. in length. The subsurface defects were caused by poor weld penetration. Inspection of the inside of this seam revealed several sur-



How ultrasonic waves locate flaw in vessel wall. "A" is pattern when no flaw is detected. "B" shows reflection from small defect. (For more on this see The Oil and Gas Journal, February 4, 1952, page 70.)



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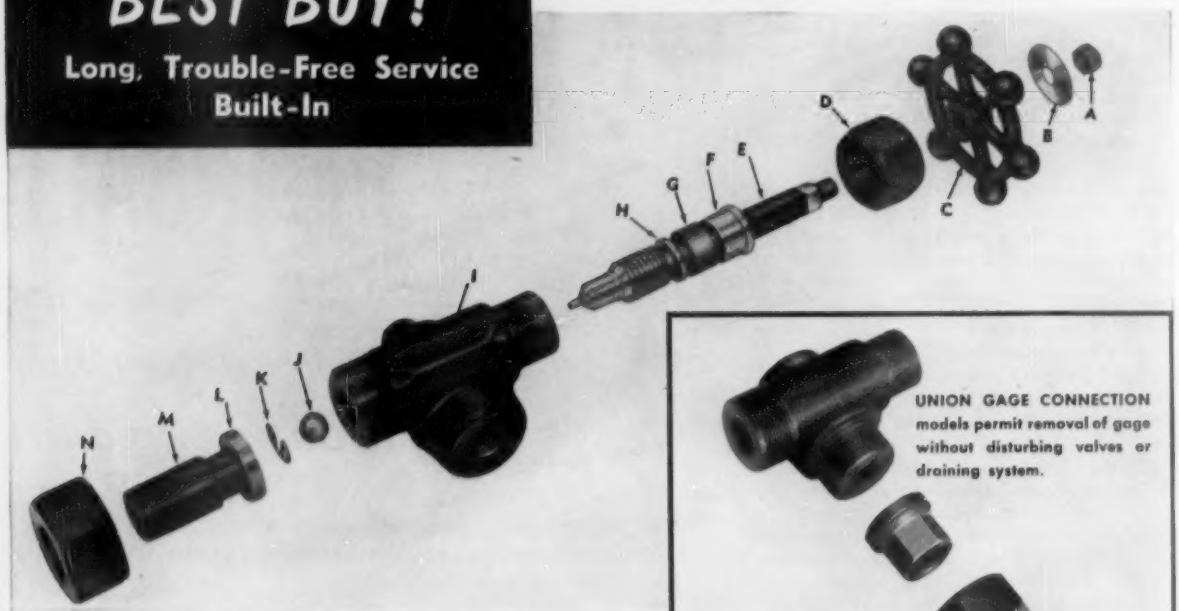
- **N** Steel Coupling Nut



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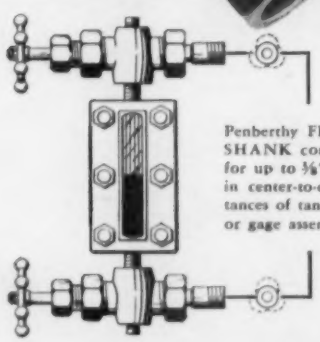

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face cracks, approximately the same length and depth as those found on the outside. This seam was welded with an automatic welding machine and had been random-radiographed in the fabricator's shop. There is no doubt that the defects found were present before the vessel was placed in operation. It is therefore apparent that random or spot-radiographing is not positive insurance of sound welds.

Cat cracker weld seams . . . Early in 1952, a program was established which called for the Magnafluxing of all welded seams and attachments in the fluid catalytic cracking reactors. On one of the units, a total of 540 ft. of weld seams of the reactor was inspected with Magnaflux. One crack 4 in. in length and ⅛ in. deep was found at the fusion line in a circumferential-shell, weld seam. In another circumferential seam, between the bottom head and the shell, a crack of 10 in. in length was found that extended completely through the seam weld and over halfway through an internal reinforcement ring.

A crack 4 in. in length was found in another circumferential weld seam, that had its start on the inside of vessel in the alloy weld. It had progressed through this alloy liner weld and ¼ in. into the main seam weld which was of carbon steel. This indication was found when Magnafluxing the outer weld. All seams in this vessel were radiographed 100 per cent during field fabrication. Two of these defects, had they been allowed to progress, could possibly have resulted in a forced shutdown. In this same reactor in 1954, cracks were found in a weld seam that were Magnafluxed in 1952 and 1953, and no indications of defect were found at that time.

Distillation unit . . . Another refinery had several line failures in a distillation unit, which were attributed to hydrogen embrittlement. Therefore an inspection schedule was set up which enabled the inspection department to check with Magnaflux all piping in this particular area every 2 years. All of these failures occurred in weld ells or hubs of welding neck flanges. During a recent turnaround several cracks were found in a hub or a forged steel welding neck.

Up to the present time, it is impossible to determine accurately where failures from hydrogen embrittlement are likely to occur. Experience has shown that lines in low and high-pressure gas systems are more susceptible than others. For this reason, these areas should be Magnafluxed from time to time. It is possible, in this way, to locate cracks that have not penetrated to a sufficient depth to cause failure.

Castings

In heater headers, and other special cast fittings, inspection with Magnaflux will reveal fatigue cracks and foundry shrinks that cannot be found by visual inspection. These cracks develop in the "mule ear" and in bodies of sectional type as well as in the box-type fittings. In some installations, these fittings are nested quite closely to each other, and it is difficult to inspect visually the entire fitting; consequently many are not observed.

With the aid of Magnaflux inspection, these cracks can readily be detected and removed by grinding. In the past, where these cracks were found by visual inspection, they had in most cases reached a depth where repairs by welding were necessary, or where fittings had to be removed and scrapped.

Serious defects, shrink cracks, cracks in foundry welds, and large slag and sand inclusions were found in high pressure turbine casings with the aid of Magnaflux. A costly repair job would have been avoided if these particular casings had been both radiographed and Magnafluxed in the foundry, and after machining.

Welded Storage Tanks

During the field fabrication of welded storage tanks, the usual inspection

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employed on vertical and circumferential seams is to spot check by trepanning plugs at arbitrary locations on the seams. This procedure is satisfactory for the circumferential seam, as a full penetration weld is not required. However, the vertical seams are the most important since they must carry the full primary shell stress. This seam and the spot where the circumferential seam ties into the vertical seams should have a sound weld. The use of Magnaflux inspection, together with other inspection procedures, should result in the elimination of dangerous weld defects from all welded storage tanks.

Welded Spheres

On new spheres, all welds at manholes, at nozzles and at the point of attachment of supports, should be Magnafluxed. The inside edge of manholes, the necks and nozzles, or similar parts, should be finished smooth and checked for cracks. All seam welds in both field and shop fabrication should be checked with the aid of Magnaflux. The number of weld inspections should be governed by the thickness of plate. After the hydrostatic test is made, all vessel attachments should again be Magnafluxed. All attachments on spheres in service should be Magnafluxed at least once every 5 years. As mentioned before, Magnaflux is not a substitute for other forms of inspection, and its limitations should constantly be borne in mind.

Magnaglo

Magnaglo is a special paste made for use in the wet method. This paste is mixed with suitable oil to form a suspension of fluorescent ferromagnetic particles. A suitable magnetic field is induced in the part to be inspected. Magnaglo will reveal only surface defects in magnetic material. Under a black light, surface indications appear as bright, greenish-yellow lines of fluorescence, and attract the inspector's eyes, rather than requiring him to search the surface for them. (Black light is harmless near ultraviolet light with a wave length of 3,200 to 4,000 A.)

Magnaglo has many advantages which warrant its use, especially in making an inspection of threaded sections, inside bolt holes, at fatigue cracks in machined parts, and on sharp changes of sections in forgings or castings, where the use of dry magnetic powders can leave much to be desired. It affords an accurate inspection in the tool crib, revealing invisible cracks caused by improper grinding, heat treatment, or careless handling, which means later savings in set up and downtime.

Zyglo

Zyglo is the name of a test method used to locate defects open to the surface. It was developed for nonmagnetic alloys, also for ceramics, glass, or plastics, but is perfectly suited for magnetic materials as well.

Defect indications are seen as lines of fluorescence, visible under black light. The markings are made primarily by the penetration of highly fluorescent liquid through a surface opening to some depth within the part. After the removal of all surface liquid, and dusting with a dry powder, the fluorescent material emerges by capillary action. The glowing indications that appear under the black light are positive clues to cracks, flaws, pinholes, and porosity. There are four essential steps in the operation of the Zyglo method. They are penetrant application, rinsing, powder application, and observation or inspection.

Application . . . This is accomplished by dipping, brushing, or spraying. The minimum width and size of a flaw which will be indicated, is controlled largely by the amount of time allowed for the penetrant to work into the flaw. The tightness of the surface opening of the defect appears to be the principal controlling factor. The time will vary from a few seconds, in the case of shrinkage cracks and porosity in castings and weldments, to 30 to 40

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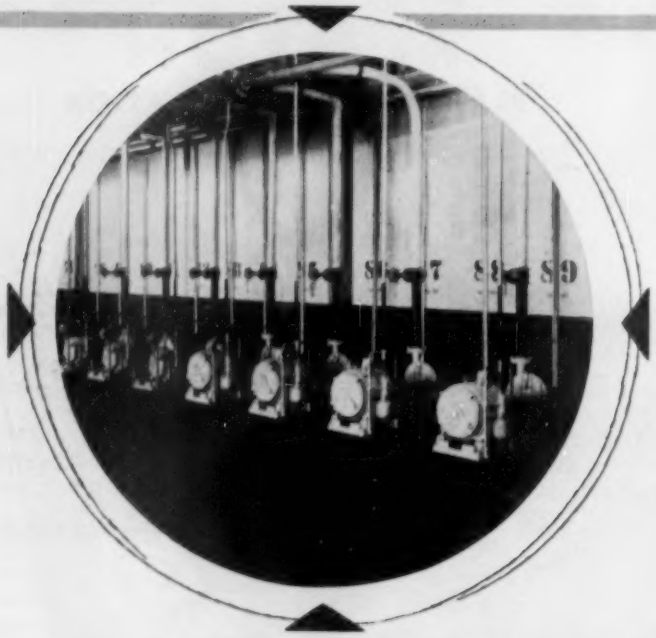

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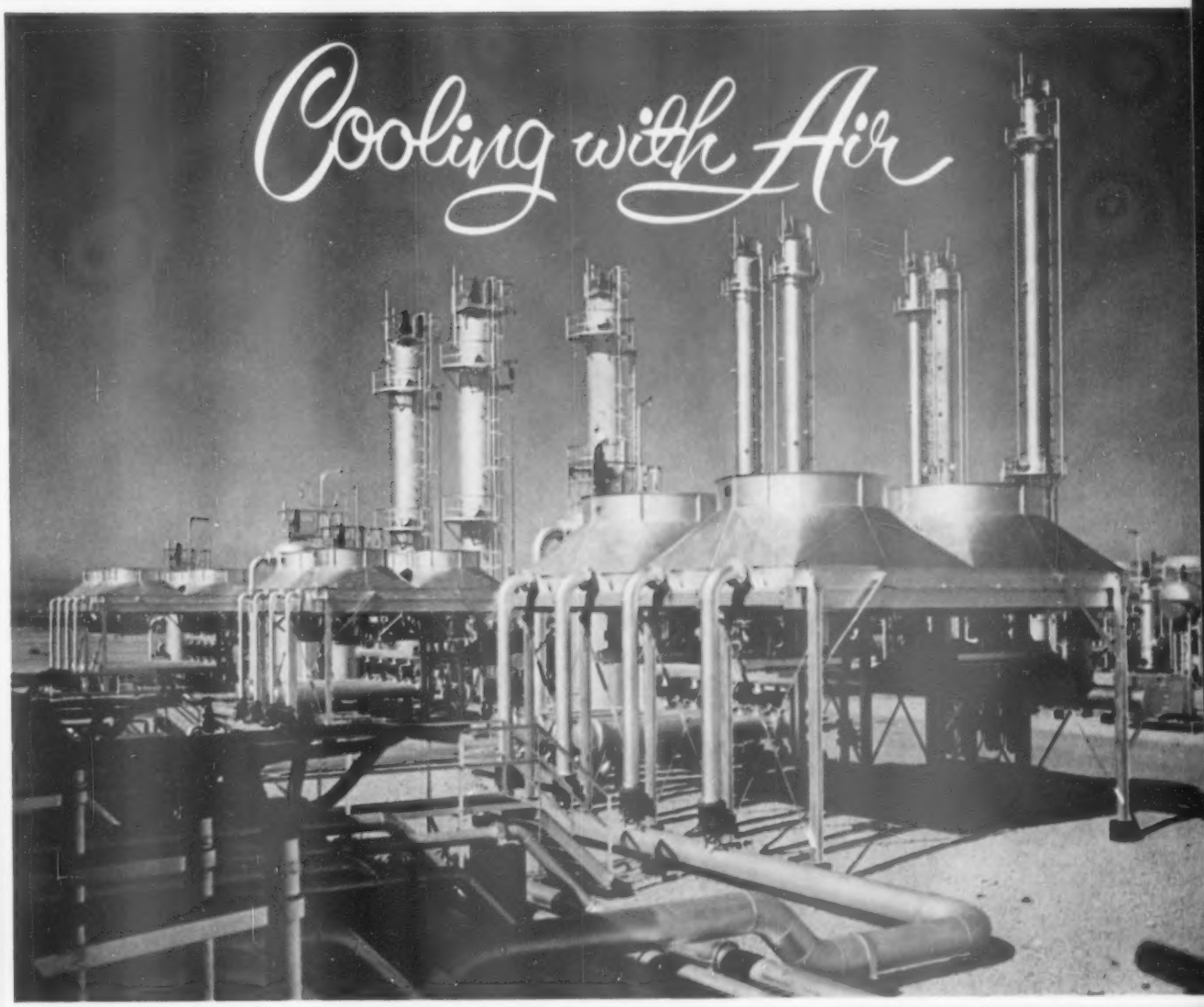

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- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**

Hudson designs and manufactures cooling systems using water exclusively, air exclusively, and combinations of air and water. Objective comparisons are furnished without cost.

Hudson Auto-Variable Pitch Fan is protected by U. S. patents and patents pending.

HUDSON
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minutes for tightly closed cracks in forgings or in 18-8 pipe or tubing.

Rinsing is accomplished by means of a water spray, preferably, but the water can be sloshed on with a bucket and rags. The part must be dried after rinsing by wiping, by hot-air drying, or by natural drying methods. An absorbent developing powder is applied to the surface and the excess is removed. The powder soaks up the penetrant like a blotter, drawing the penetrant out of the flaws to the surface.

Preparations are simple. It is necessary to clean any oil, acid, alkali, or scale from the surface to be checked. Most oils are fluorescent; acid and caustic will kill fluorescence. On welds, sandblasting is very advantageous. Shotblasting peens over indications, and buffing will cover many small discontinuities. Next, the penetrant is applied, the excess is removed by washing, the part is dried, the developer is applied. The part is then inspected under the black light.

Apply penetrant outside . . . In vessels, the detection of leaks through welded joints of new tanks has been very effective. The Zyglo method is especially useful in checking the seam at the junction of the shell and the bottom, when uneven surfaces prohibit the use of the angle box of the vacuum seam tester. When possible, the penetrant is applied to the outside and checked from the inside.

On vessels that have been in service, the penetrant must be applied from the inside, because of the fluorescent property of most oils. Wherever current is not available for the conventional black light equipment, there has been developed a portable battery-operated unit which can be used. It is much slower but is effective and has the added advantage of being a daylight fluorescence detector.

Seal welds of rolled-in furnace tubes, or exchanger tubes, can all be Zygloed, with very satisfactory results. Nonmagnetic thermowells, coil springs for relief valves, new lead lining, and vapor sample bombs can be inspected in this manner.

Audigage

The Audigage is a portable, self-contained instrument designed to measure the thickness of a wide variety of materials, including steel, when only one surface is available to the inspector. Its application to determination of thickness of pipes, storage tanks, and pressure vessels provides rapid results. But considerable trouble has been experienced with the older-type instrument, which gave only audible indications through a set of head phones. The latest model (FM-SS-5) gives both audible and visual indications, and provides greater sensitivity and reliability.

Power for the instrument is supplied by a battery included in the instrument case. This fact eliminates the inconvenience of running long power cords to remote places.

Audigage inspections . . . In preparing for Audigage inspections, a thin film of oil, or grease, or glycerin is used to provide a good ultrasonic coupling between the crystal and the work. On smooth surfaces, the sound wave can be transmitted through thin layers of mill scale, rust, or thin paint coats. On rough or on heavily painted surfaces, a file or grinder must be used. There is a flat crystal for flat plates or for tanks or surfaces with relatively large radius or curvature. Curved crystals, cut to fit the curvature of pipe, can be obtained, and they improve indications considerably in that area.

Although the manufacturer states this instrument will measure steel thickness over a range of 0.125 to 12 in., it has been our experience that measuring the thickness of steel under $\frac{1}{4}$ in. is difficult. It also has been difficult to determine with any degree of ac-

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curacy, corrosion pitting or uneven wear. In one instance the latest-type Audigage was used to determine the remaining wall thickness in the reactor vapor line of a fluid catalytic cracking unit. Test holes were made to check the results obtained with the instrument, and the results showed the Audigage readings to be within 2.0 per cent of being accurate.

This instrument has merit and is ideal for measuring heavy-wall vessels or pipe. Not only can it be used for testing steel, but also for testing many other materials, such as brass, aluminum, copper, nickel, and glass. The instrument will, however, give no indication when used on cast iron, concrete, or other porous materials.

Penetron

The Penetron is a thickness-measuring instrument which uses the gamma-ray radiation principle. It is portable, but is best operated by two men. Readings to an accuracy of minus or plus 3 per cent can be obtained. The time required for making measurements is roughly 25 seconds. Wall-thickness measurments can also be made on pipe or vessels which contain liquids, provided a correction is made to take into account the influence of the fluid on the reading of the instrument. The magnitude of this correction is dependent upon the density of the fluid. However, for practical purposes, the necessary correction can be made simply by establishing a calibration curve for pipes of known wall thickness filled with the same fluid. These curves have to be established only once.

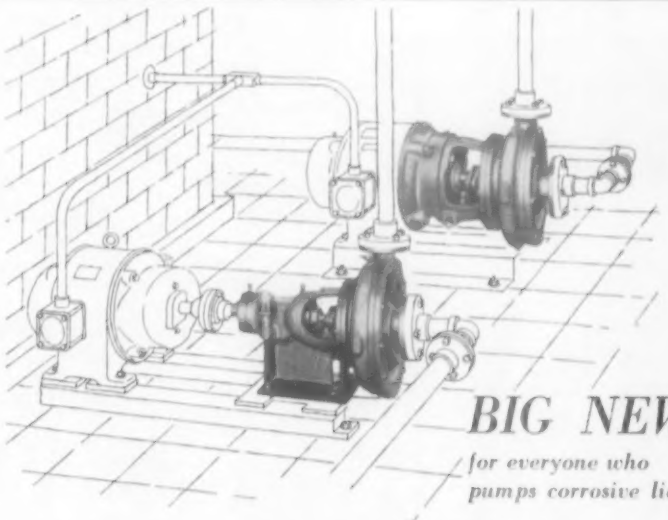
Liquid level . . . The liquid level in a vessel can be determined by placing the head of the Penetron on the vessel wall above the level of liquid, and moving the head down along the wall. The reading of the instrument will remain constant, until it reaches a point opposite the level of the liquid in the vessel.

The Penetron indicates the combined thickness of metal, coke, or scale. Therefore, the operator must have a rather broad knowledge of refining processes to use this instrument effectively on lines or vessels. He must know from past experience, which equipment is reasonably clean. No attempt will be made to list these locations. All of the refinery inspection departments are familiar with their particular processing equipment, and from experience, know the location of vessels and lines where this instrument can be used to advantage. Thickness measurements with an accuracy of plus or minus 3 per cent can be obtained in the range of 1/32 to ¾-in. thickness, with temperatures ranging up to 800° F.

Regarding equipment required, it has been the usual experience that standard tangential heads, 6¾ and 12¾ in., are sufficient to cover pipe or vessels from 3 in. in diameter and up. The manufacturer furnishes a pneumatic holder for the standard head for measuring heater and boiler tube walls.

Limitations . . . The Audigage and Penetron are useful instruments for measuring the thickness of vessel and pipe walls, but have certain limitations that must be observed. Drilling and plugging, weep holes, calipering, and visual inspection have always been exact methods of determining the wall thickness of critical lines, vessels, and other equipment. It is not intended that either of these instruments should be used in lieu of the older proven methods. However, savings from the use of these instruments are effected by eliminating special preparations and tools and costly shutdowns. Their use on tanks, pressure vessels, and pipe are many.

There are many other types of nondestructive instruments available today. However, it is felt that if all refineries were equipped with those mentioned in this report, and if they were intelligently used, the number of unscheduled shutdowns, because of failure of equipment, would be lessened considerably.



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How to Keep a Refinery on Stream

Sinclair's inspection department organized to function in (1) maintenance, (2) new construction, (3) equipment manufacture

by W. T. Gooch

CERTAINLY the primary job of a refinery inspection department is to assure the safe and continuing operation of refinery equipment. But in doing that job, this department acquires the personnel and the records that also equip it to carry out other, secondary jobs. This is the story of how one such department is organized so that it can do these secondary jobs without detracting from its primary job.

The practices outlined here were established in a 125,000-bbl. per day refinery with these facilities: (1) four crude-distillation units, two of which were built recently; (2) one fluid and one T.C.C. catalytic cracking unit; (3) five thermal crackers and one reformer; (4) an alkylation unit; (5) a propane deasphalting and phenol lube-treating unit; (6) an MEK dewaxing unit, and (7) wax filtering packaging facilities and a large packaging plant.

In addition, complete auxiliary lube and light-oil-treating facilities and gas-recovery units are covered by the inspection department. Crude oils are delivered by pipeline and products are shipped by pipelines, tank car, barge and tanker.

Procedure needed . . . It became very apparent that a definite procedure must be set up to handle inspection requirements. So a detailed study of the inspection procedure used at various refineries in the area was made. And out of this, the inspection procedure now in effect was set up.

The fields covered by the refinery inspection group are divided into three general categories of which the first takes precedence: (1) maintenance; (2) new construction; and (3) equipment manufacture.

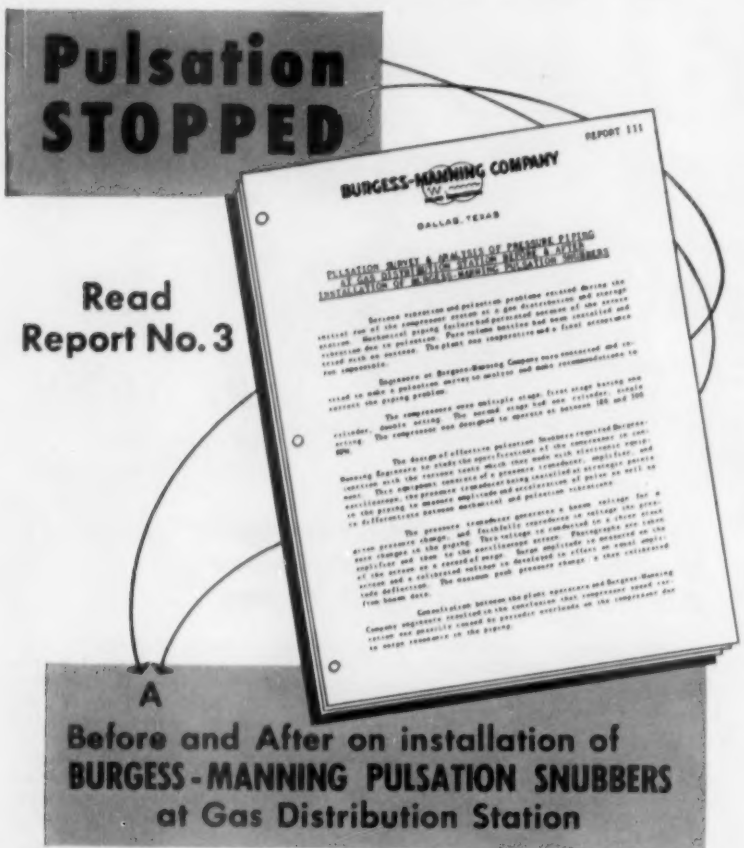
The problem of controlling corrosion also enters into the group's duties because inspection of installed equipment pertains most directly to corrosion control.

Shutdown inspections . . . Most maintenance inspection takes place during the coordinated periods of unit shutdown in accordance with previously prepared work lists. Such inspections have three immediate objectives. They find the amount of deterioration due not only to corrosion but also to erosion, cracking, spalling, sagging, and settlement. They form the basis for recommendations of suitable methods of repair or replacement that will assure continued safe operation. And they make sure that the repair or replacement is satisfactorily completed.

In carrying on the inspection, the group handles various types of instruments and equipment. Some of these are: Magnaflux; Zyglo; supersonic thickness indicators; radium capsules; numerous types of calipers, both electric and manually actuated; depth gages; and hardness testers.

Department organization . . . At the present time, the inspection department consists of five inspectors and one foreman. To utilize this personnel to the

Author is with Sinclair Refining Co., Houston, Tex.



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3. The combustion gases, at the top of the heater, are diverted towards the walls where they recirculate from the top of the heater downward, behind and between the tubes, increasing the heat input to the rear of the heating elements by convection;

4. The recirculated gases reduce the heat intensity at the bottom of the furnace so that the heat input is the same, top and bottom.

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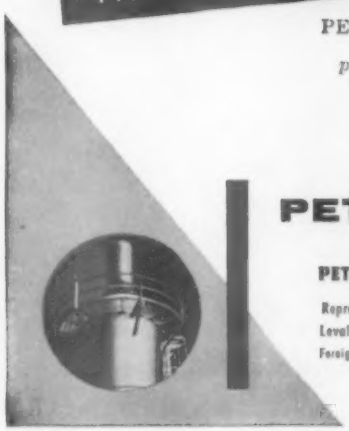

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best advantage, the plant is divided into four areas with an inspector assigned to each. These areas contain these facilities:

... **Area 1.** One alkylation unit, one gas-recovery plant, and one thermal cracker, and one reformer.

... **Area 2.** One 50,000-bbl.-per-day fluid unit, one 10,000-bbl.-per-day T.C.C. unit, one 35,000-bbl.-per-day crude still including desalter and vacuum tower, one 50,000-bbl.-per-day crude unit and desalter, and one 12,000-bbl.-per-day Houdry unit (out of service, capacity not required).

... **Area 3.** One 15,000-bbl.-per-day sour-crude unit and vacuum tower, four thermal crackers, one gas-recovery plant, and one finished wax plant.

... **Area 4.** One refinery light-oil treating facilities, one lube vacuum unit, one propane-phenol unit, one MEK-solvent dewaxing plant, the refinery boiler house, the refinery packaging department, and the refinery lube-treating facilities.

The fifth inspector works at large and is used on various jobs outside the four zones. He also aids the various inspectors in the inspection of their respective areas and assists in writing their inspection reports.

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Procedure . . . The procedure that is followed by an area inspector is threefold. First, during a unit turnaround all inspectors work as a team in handling the inspection of a particular unit.

Second, when inspection work done by the group is finished, the inspection data is compiled and the necessary inspection report worked up by the inspector in whose area the inspection work was performed.

The inspection report is complete in every detail. It includes pertinent information on condition of the equipment and anticipated life, as well as a description of coke deposits, etc. The area inspector attempts to complete this report not later than 2 weeks after completing the inspection.

Third, when there are no units down for inspection and repairs, the area inspectors direct their activities to followup work in their respective area.

This followup work includes investigation of progress in making materials for future turnarounds. This requires full understanding of engineering department instructions as well as the actual progress of mechanical work in the various shops. To help the area inspector in this followup work, the engineering department furnishes the inspection department with copies of all prints on major changes or revisions to be made during a unit turnaround.

Followup work also includes looking into the status of material ordered for installation during a future turnaround. This requires familiarity with material requisitions, storehouse inventories, and storehouse records covering purchase orders, vendors, and expected delivery dates. The engineering department furnishes a copy of all purchase requests submitted by the operating foreman for material to be installed during a turnaround. These copies indicate the storehouse requisition number.

To do this followup, the area inspector must prepare a consolidated, itemized list covered by the purchase request for each particular unit. This list indicates the requisition number, purchase-order number, name of vendor, anticipated delivery date, and date actually delivered. All of the above data is maintained in a material-requisition log book.

Followup work also includes checking inventories of material not normally requisitioned or ordered for special maintenance jobs. This is especially done when it is known that the repairs planned will require an abnormal quantity of certain stock items.

Inspection foreman . . . The chief function of the inspection department foreman is to act as a coordinator. He co-

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ordinates the activities of the area inspectors and follows up to make certain that this procedure is followed.

After the inspection of a particular unit, the inspector foreman will prepare a report of items requiring attention and planning prior to the next turnaround of the particular unit. This report, which consists of the original and five copies, is directed to the operating department head.

If the report is satisfactory, the operating department head will approve by signing all copies for redistribution as follows: First copy to the inspection department; second copy to the engineering department; third copy to the master mechanic; fourth copy to the industrial engineer; and fifth copy to the storekeeper.

If there are items on which disagreement may arise, these items are brought to the attention of the manager's office for immediate discussion.

Preshutdown . . . Prior to a unit turnaround, preshutdown-planning meetings are held where the turnaround work schedule is discussed. The inspection foreman and the respective area inspector attend this meeting for presentation of information as to the status of material and equipment needed for that particular turnaround.

As a result of this meeting, if it appears that the preshutdown work is not progressing satisfactorily or material is not available or being received as expected, it is the duty of the inspection foreman and area inspector to bring these facts to the attention of all concerned.

On new construction work, the refinery inspectors check on the workmanship of the contractor's field crew with particular emphasis on welding and testing. On new construction projects involving large tanks or field-erected pressure vessels, the efforts of the refinery inspectors are usually supplemented by inspectors from the central inspection department where specially qualified personnel is available.

Inspection of new equipment being made in outside shops is not normally the responsibility of the refinery inspection department. Usually, this work is assigned to the central inspection department where a staff of inspectors covers such work for the entire company. On rare occasions, the refinery inspectors are called in to supplement the efforts of the central inspection department in covering fabricator shops in the vicinity of the refinery.

Besides their operating-unit-inspection duties described above, the inspection department keeps up run-data logs of all operating units, calculates operating efficiencies, and compiles annual reports on run distributions of these

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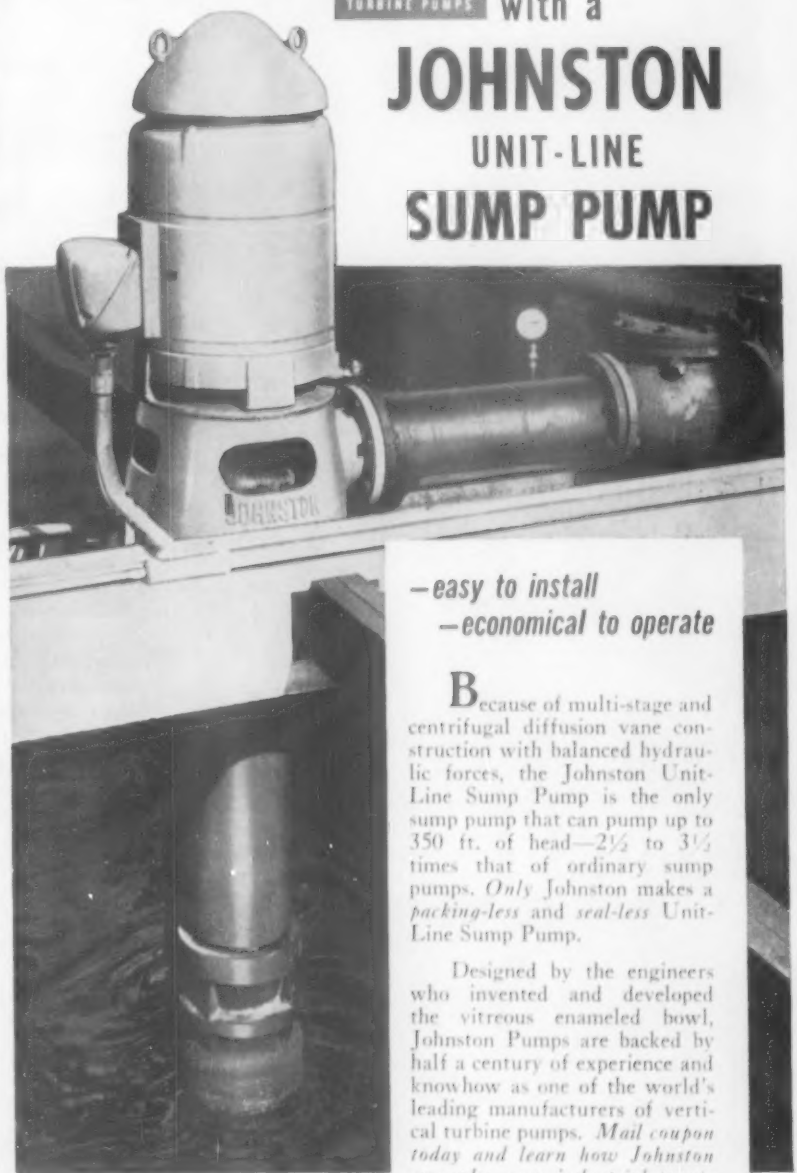

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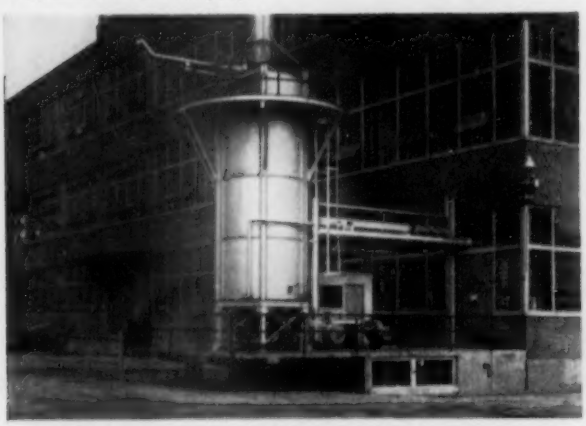
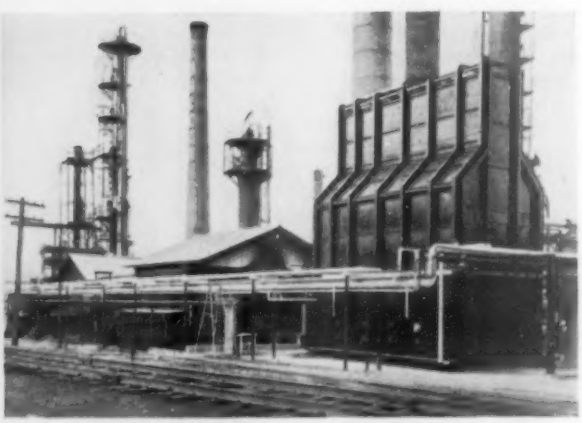


A fired heater for Struthers Wells Dowtherm heating system, one of two units installed in a new chemical plant for the production of vat dyes.



Shown above are two Struthers Wells heaters in petroleum refinery service. At right is a three-coil heater used in catalytic reforming of gasoline. At left is a heater which was installed over 23 years ago, and is still in continuous service.

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units. They assist the various operating departments in planning turnaround schedules and in coordinating maintenance work on unit turnarounds.

Conclusions

Results . . . This organization and procedure have worked very well since 1951. Greater efficiency of maintenance forces and reduced operating-unit down time have resulted from their use.

BOOKS

THE ROLE OF PETROLEUM IN MODERN TRANSPORT. Edited by George Sell. Published by the Institute of Petroleum, 26 Portland Place, London, England. 185 pp., $4.16 postpaid.

This book is the published report of the I.P.'s May 1954 meeting. These chapter headings give the best summary of its contents: (1) the transport industry; (2) land transport by rail; (3) fuel problems in road transport; (4) lubrication problems in road transport; air transport fuels; (5) lubrication of aircraft; (6) sea transport fuels; (7) lubricant requirements of sea transport; and (8) future trends in quality of fuels and lubricants used in transport. Each chapter is a meeting report, with discussion comments appended. This is the first book written on this subject.

ISOTOPE GEOLOGY. By Kalervo Rankama. Published by McGraw-Hill Book Co., 330 W. 42nd Street, New York 36. 535 pp., $12.

The title, "Isotope Geology," is a term coined by the author to cover the geological applications of nuclear research. This text is intended to serve as an introduction to the physics, chemistry, and natural science of nuclides and their many applications. Some of these applications are: determination of the absolute geological age of minerals and rocks; measurement of paleotemperatures; the study of the chemistry of the earth during early stages of its evolution; and development of an atomic calendar for establishing the age of ancient remains and formations.

STANDARD METHODS FOR TESTING PETROLEUM AND ITS PRODUCTS, fourteenth edition. Published by the Institute of Petroleum, 26 Portland Place, London, England. 688 pp., $5.57, postpaid.

This fourteenth edition of the I.P. standards contains 7 new methods, 22 revised methods, and 2 revised specifications. Covering every phase of petroleum-product testing, it follows as closely as possible the suggestions for method arrangement given in "Recommendations on the Form of A.S.T.M. Methods." All methods are arranged both alphabetically and numerically for easy reference.

MINERALS IN WORLD INDUSTRY. By Walter H. Voskuil. Published by the McGraw-Hill Book Co., 330 W. 42nd Street, New York 36. 324 pp., $5.75.

The role of minerals in industrial productivity is the subject of this authoritative text on minerals in their economic and political aspects. It especially brings out the role that minerals have played in the formation of American production techniques and living standards.

Only four of the book's 27 chapters are devoted to oil and natural gas. But the value of this book to oil men is that it places petroleum in perspective against a backdrop

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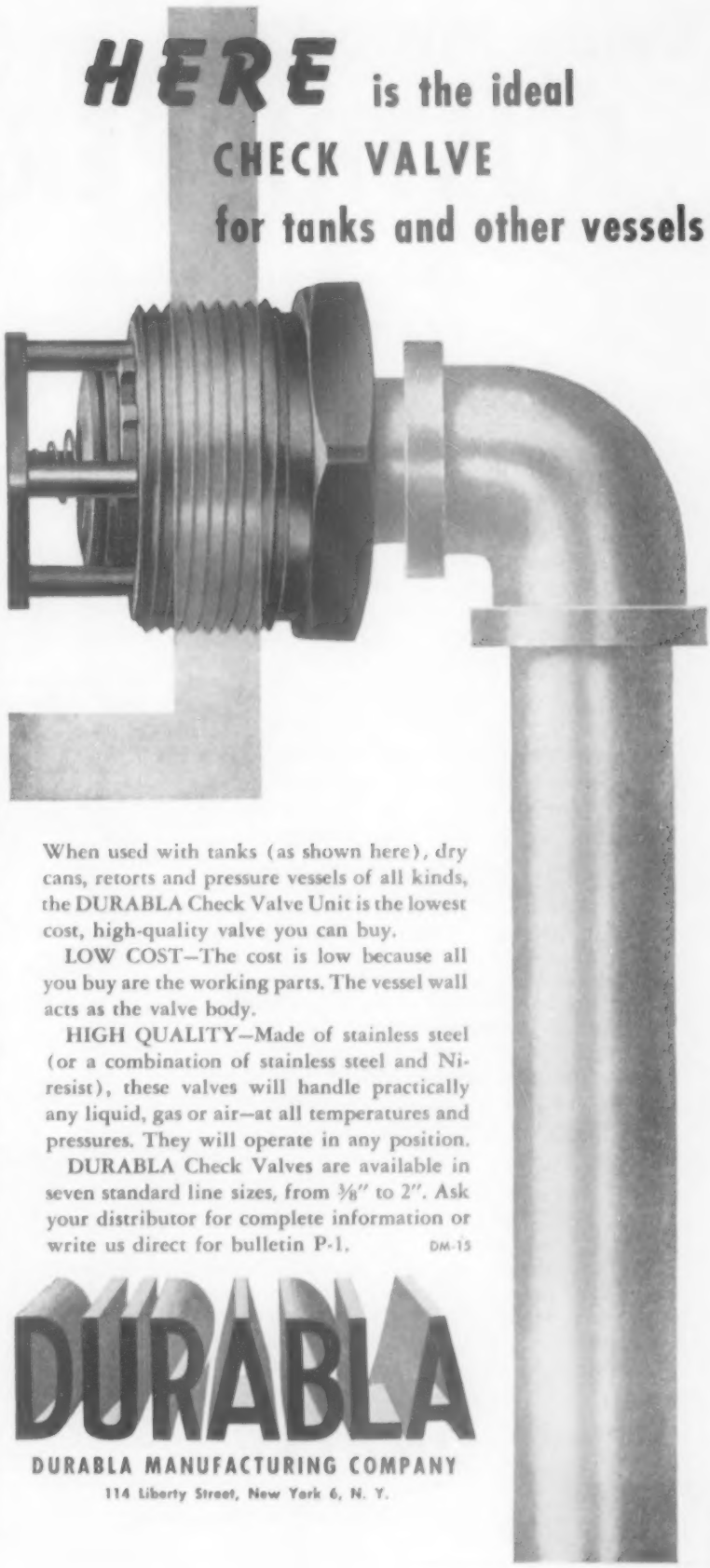

When used with tanks (as shown here), dry cans, retorts and pressure vessels of all kinds, the DURABLA Check Valve Unit is the lowest cost, high-quality valve you can buy.

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Texas refinery saves $1200 in ONE cleaning operation

Refiners everywhere are finding more and more uses for revolutionary Oakite RUSTRIPPER. This remarkable NEW alkaline material simplifies practically every cleaning job... reduces costs, too. Here's how amazing Oakite RUSTRIPPER saved one Texas refiner $1200 in a *single* cleaning operation:

The problem was to recondition a 28-tray, 5 man-way oil absorber tower containing 2304 four-inch bubble caps. Last cleaning had taken 24 hours —an extremely expensive proposition, since every hour of down-time costs this refinery $100! The superintendent agreed to give Oakite RUSTRIPPER a try.

After rinsing the tower with steam and hot water for two hours, a pre-mixed solution of Oakite RUSTRIPPER was pumped into the unit from a 1000-gallon tank mounted on skids nearby. The solution was recirculated and agitated for ten hours at 210°, then routed through the mist extracter for an additional three hours, and drained out. A three-hour circulating water rinse completed the cleaning cycle.

Results? Oakite RUSTRIPPER had not only accomplished a cleaning job that was 95% perfect, but had reduced down-time by *six* hours, slashed cleaning costs by *$1200!*

Oakite RUSTRIPPER is also excellent for reconditioning salvaged parts, stripping paint from metal equipment, and many other heavy-duty refinery conditioning chores. RUSTRIPPER is safe, too... won't attack sound metal or give off troublesome fumes. Your local Oakite Technical Service Representative will gladly demonstrate remarkable Oakite RUSTRIPPER for you at your convenience. Call him today... no obligation. Or write Oakite Products, Inc., 44C Rector St., N. Y. 6, N. Y.

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of all the world's mineral resources. And in doing so, it presents an objective, balanced view of oil's role in world mineral economics.

Carefully integrated, crisply written, and well-illustrated, this is an interesting and valuable book for both technical personnel and general industry people.

TRAFFIC MANAGEMENT. By Charles A. Taff. Published by Richard D. Irwin, Inc., Homewood, Ill. 570 pp.

Traffic management personnel and others seeking up-to-date information in this field will find this book both complete and authoritative. It offers a thorough presentation of the services available to the traffic manager by rail, motor, water, air, and pipeline. It outlines such elements of traffic management as government bills of lading, movement of household goods, and site selection. And it explains how traffic managers can develop their stature and importance by integrating the traffic needs of their companies with production and marketing requirements.

A SURVEY OF RESISTIVITIES OF WATER FROM SUBSURFACE FORMATIONS IN WEST TEXAS. By the Permian Basin Chapter of the American Institute of Mining and Metallurgical Engineers. Published by the Schlumberger Well Surveying Corp., Midland, Tex. 50 pp., $1.50.

This is the report of a survey conducted by the West Texas Water Resistivity Subcommittee of the Permian Chapter of the A.I.M.E. It gives a county-by-county listing of water resistivity encountered by oil companies operating in West Texas. The statistics do not cover all of the producing zones. But they do cover a broad enough group to provide a fairly reliable statistical base. In all, they should prove most helpful to reservoir engineers and others engaged in reservoir calculations.

FOREIGN OIL AND THE FREE WORLD. By Leonard M. Fanning. Published by the McGraw-Hill Book Co., 330 W. 42nd Street, New York. 400 pp., $6.

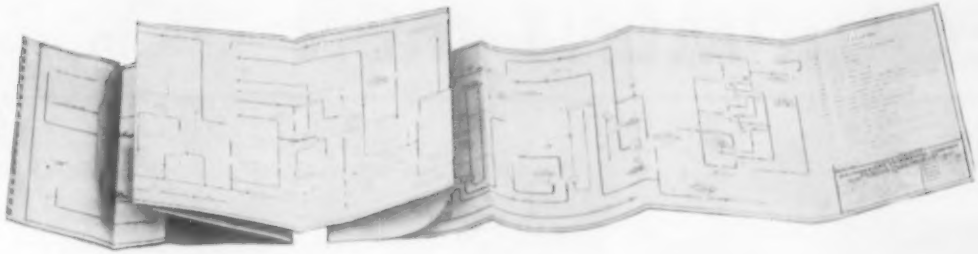
Here's an up-to-date report on the international oil situation, written by the author of the "Petroleum" article in the Encyclopedia Britannica. Fanning, the former public-relations director of the American Petroleum Institute, has used his 35 years' experience in the oil industry to bring into sharp focus the current picture of international oil diplomacy.

It's a vivid portrayal of America's stake in foreign oil, of the technological and diplomatic steps America has taken to protect that stake, and of the powerful political and economic assault that the Communist world has directed against the free world's oil position. It offers an expert's analysis of the expropriation of Mexican oil lands, Venezuela's initiation of 50-50 profit sharing, and the diplomacy behind the 3-year Iranian oil dispute. And it tells the dramatic story of the overseas operations of American oil companies.

All of these actions and events are placed in perspective against the historical backdrop of the past 50 years. The result is an informative, interesting, easily read report on a subject of growing importance to American oil men.

GERMAN BOOKS ON CHEMICAL AND COGNATE SUBJECTS, 1950-1953. Edited by A. E. Cummings and S. Vince. Published by Lange, Maxwell & Springer, Inc., 122 E. 55th Street, New York 22. 63 pp.

This is a supplement of important German scientific works published between 1950 and early 1954. Each book included is listed by author, title and subtitles, and number of pages. Its editors are members of the Chemical Society of London.



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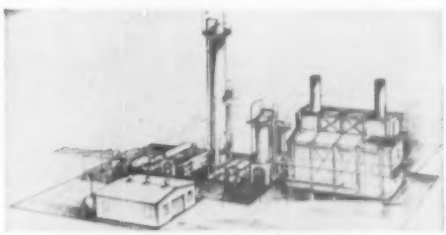
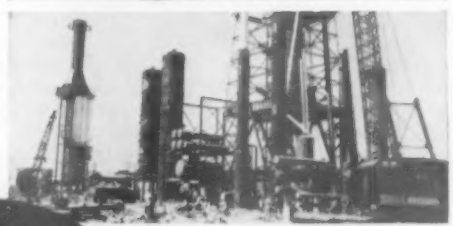
SWECO flow sheet, 9,000 B/D fluid cat cracker

How to get on-stream in record time with upgraded refinery products

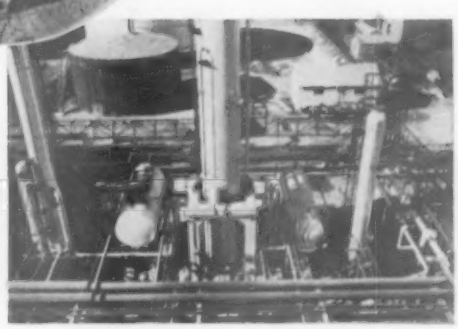


COMPLETE ENGINEERING
SWECO perspective, 5,000 B/D platformer



FIELD CONSTRUCTION
SWECO 6,000 B/D TCC unit, under construction

SHOP FABRICATION
SWECO kiln for 6,000 B/D TCC unit



ON-STREAM
SWECO-built 300 B/D cat poly plant, in operation

Today's demand for maximum output of high octane gasoline and other upgraded products from every barrel of crude oil is literally forcing refiners to install new catalytic process plants. Continued profitable operation may depend on getting on-stream with the new process in a hurry. SWECO's combination of engineering, shop fabrication and field construction is enabling refiners... in many parts of the U.S. and abroad... to get new catalytic plants of *assured dependability* in operation fast.

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EQUIPMENT MEN . . . in the News

Cathodic Protection Adds Six Corrosion Engineers

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F. CLARK

J. SEARCY

F. DORR

J. DAVIS

During the past year, Cathodic Protection Service, Houston, had added six corrosion engineers to its staff and has opened two additional branch offices.

Hugh Wilbanks heads the new Corpus Christi, Tex., office, Franklin Clark is in charge of the new Denver office, John Searcy has joined the Tulsa office staff, and Frank Dorr, Jack Davis, and Floyd Thorn represent additions to the main office staff at Houston.

Thorn is spending full time on the development of the new field of cathodic protection as applied to oil-field equipment such as heater treaters, salt-water tanks, filters, and other flood-handling equipment as well as the soil side of well casings.

These additions bring Cathodic Protection Service's staff of corrosion engineers to a total of 19 in 5 offices, and brings the combined cathodic - protection experience, represented by this staff, to a total of over 150 years.

Oilwell Transfers Tipton From McCamey To Odessa

Transfer of Harold S. Tipton, field representative for Oilwell, from McCamey to Odessa, Tex., has been announced recently by William Miskimins, manager of the Central Midwest area for U.S. Steel's Oil Well Supply Division.

Tipton was employed in 1947 at Oilwell's Odessa store. Two years later he was named field representative for the division at Odessa. In 1950 he was transferred to Snyder, Tex., in this capacity and in 1951 was transferred back to Odessa.

Tipton's later Oilwell service was at Denver City, Tex., and McCamey, where he was located until his present transfer.

Dresser's Offer Accepted By Lane-Wells Stockholders

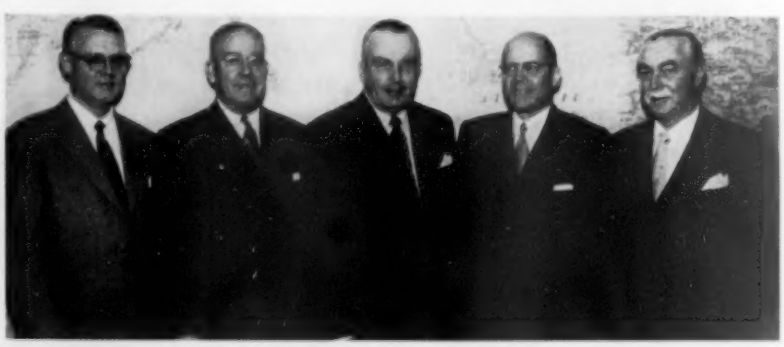
By a substantial margin Lane-Wells Co. stockholders have voted to become one of the Dresser Industries. At a special meeting held February 28 in the Lane-Wells offices in Los Angeles, approval was given to a plan under terms of which assets of the company will be acquired by Dresser Industries, Inc., Dallas. The plan provides that Dresser will issue 576,000 shares of common stock which the Lane-Wells stockholders will receive on the basis of four shares for each five shares of Lane-Wells presently held.

Of the 596,167 shares represented at the special meeting, 567,763 shares, or 95 per cent, voted in favor of the plan. Dresser took over the ownership of Lane-Wells as of March 1 and the Dresser shares will be issued to Lane-Wells on or before March 30, for final distribution to the company's stockholers.

In commenting upon the transaction, Rodney S. Durkee, chairman of Lane-Wells, stated, "Lane-Wells pioneered the now widely used and essential service of perforating oil and gas wells. It also developed the highly important technique of radioactivity well logging. I firmly believe that, having united our interests with those of Dresser Industries, Lane-Wells will be in a better position than ever to broaden its service to the rapidly growing oil and gas industries here in the United States and can take particular advantage of Dresser's sales and service facilities elsewhere in every important producing area of the world."

H. N. Mallon, president of Dresser Industries, commented, "We are delighted to join forces with such an outstanding organization as Lane-Wells. The business will continue to be carried on by the same management and personnel and under the same name. The acquisition is especially significant to Dresser not only because Lane-Wells is growing rapidly, but also because its services and products are of an expendable character. Coupled with such other expendable products of the Dresser group as drilling mud, drilling bits, and repair parts, the effect of the Lane-Wells acquisition is to place about 45 per cent of Dresser's total sales volume in the expendable category."

Other members of the Dresser group include Clark Bros., Olean, N. Y., manufacturer of engines and compressors; Dresser Manufacturing Division, Bradford, Pa., pipe couplings and repair devices; Dresser-Ideco, Columbus, prefabricated steel towers for electronic communication; Ideco Division, Dallas and Beaumont, Tex., rotary drilling and servicing rigs and related equip-



Lane-Wells Co. and Dresser Industries, Inc., executives in attendance at meeting where Lane-Wells stockholders voted to become one of the Dresser Industries. Left to right: John J. Neale, president, Lane-Wells; Walter T. Wells, founder-chairman; Rodney S. Durkee, chairman of the board; H. N. Mallon, president, Dresser Industries; and J. B. O'Connor, executive vice president, Dresser Industries.

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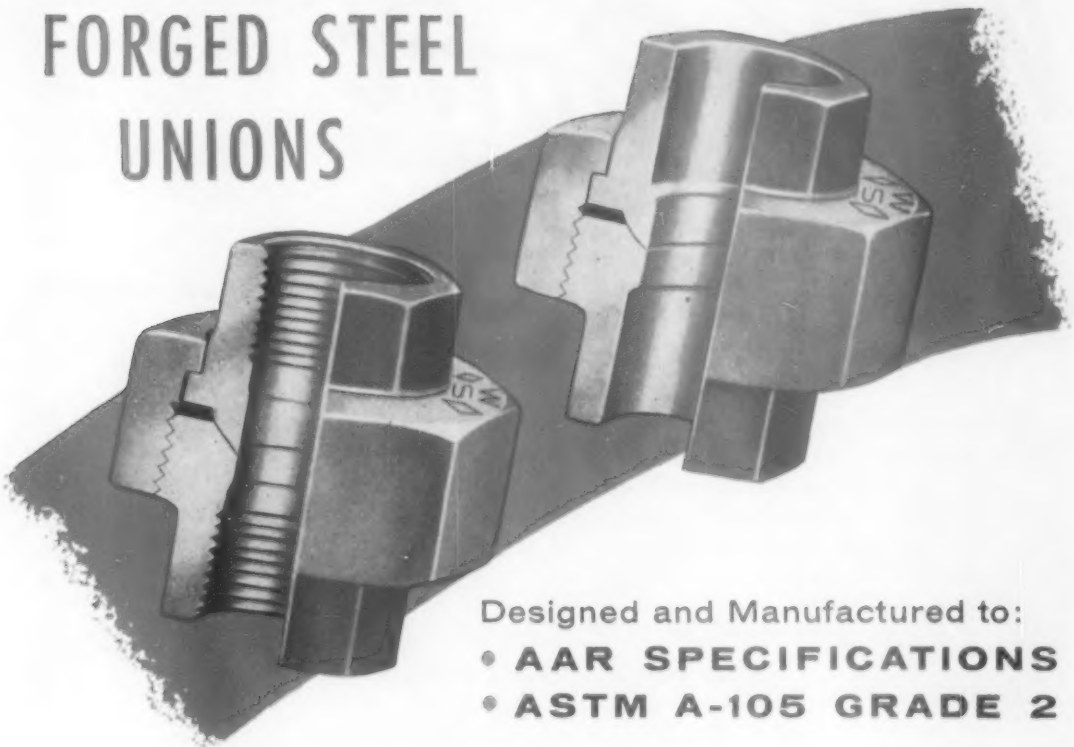

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ment; Magnet Cove Barium Corp., Houston, Malvern, Ark., and Greybull, Wyo., oil-well drilling-muds fluid additives; Pacific Pumps, Huntington Park, Calif., centrifugal pumps for refineries, pipelines, and electric utilities; Roots - Connersville Blower, Connersville, Ind., exhausters, blowers, compressors, and meters; Security Engineering, Dallas, and Whittier, Calif., rotary drilling bits, reamers, and related drilling equipment.

Dresser's executive headquarters and general offices are in Dallas.

Rockwell Makes Willes Nordstrom Product Manager

W. D. WILLES

W. D. Willes, former general manager of Rockwell Manufacturing Co.'s Nordstrom valve plants at Barberton, Ohio, and Oakland, Calif., has been named product manager, Nordstrom valves, with headquarters at Pittsburgh. According to L. A. Dixon, Jr., vice president in charge of the Meter & Valve Division, the promotion is a part of a program to expand and centralize the Nordstrom sales division.

Willes succeeds Orville W. Barnett, who has been named manager of Nordstrom distribution and oil-field sales. Willes was general manager of the Barberton plant from 1952 to 1953, when he assumed the general managership of the Oakland plant. He joined the Nordstrom Valve Division in 1944 as an industrial engineer in charge of methods and standards. In 1947, he was made production manager at Oakland and in 1949 was promoted to works manager, a post he held until his transfer to Barberton.

Oil Base Names Two New No-Glo Distributors

Two new distributors for No-Glo oil, a nonfluorescing oil used in emulsion muds, has been announced by George Miller, president of Oil Base, Inc., Compton, Calif.

Raymond S. Allred (doing business as Allred Oil Co.), Odessa, Tex., has been appointed an authorized distributor in the West Texas area. Bulk-storage facilities are located at Odessa.

Gulf Coast Pre-Mix Mud Service, Lafayette, La., will supply No-Glo on a nonexclusive basis to fields in and around the central part of Louisiana. Storage and transportation facilities are maintained by the company at Lafayette.

Technical Writer Joins Darwin H. Clark Agency

Frank Thorne, prominent technical writer and authority on advertising production, has joined the staff of Darwin H. Clark Co., West Coast advertising agency, as a technical writer and production manager. For the past 5 years, he has been advertising manager of Baker Oil Tools, Inc., of Los Angeles and Houston.

Thorne has written many articles on petroleum, including "The History of California Oil" for the American Petroleum Institute quarterly and a similar article for the Fiftieth Anniversary Issue of "Westways."

For 10 years previous, he was with United States Corps of Engineers and was chief administrative assistant of the Fifth District Region with headquarters in Santa Maria, Calif. In this capacity, he was in charge of all administrative work in connection with approximately $150,000,000 of construction, including Camp San Luis Obispo, Camp Cook, Hoff General Hospital, and Santa Maria Military Air Base.

Mission Makes Talbert Field Service Engineer

W. C. TALBERT

W. C. (Bill) Talbert, Jr., has been appointed field service engineer for Mission Manufacturing Co., W. T. Campbell, executive vice president for Mission, has announced. Talbert joined Mission in 1946 as an engineer trainee. With his new appointment Talbert will work in both foreign and domestic fields on the testing and service program of Mission products.

Three Firms Set Up Irex For Resources Studies

Three well-known firms in the field of natural resource exploration, inventory, use-planning, and engineering have joined facilities to form a group called International Resources Engineering & Exploration Group.

The three firms are Jack Ammann Photogrammetric Engineers, San Antonio, Tex., Brown & Blauvelt, consulting engineers, New York City; and Geophoto Services, consulting geologists, Denver. Formation of Irex does not represent a merger, but pools the related facilities of the three companies to provide an integrated service in all phases of natural resource studies.

The Jack Ammann organization, with a staff of 200, is best known for aerial photography, field surveying, topographic mapping, and photogrammetry for mining and petroleum exploration, and general engineering applications.

Brown & Bauvelt have a staff of approximately 200 engineers, draftsmen, technicians, and economists. The firm engages in a broad variety of engineering services, including the development of power and reclamation programs.

Geophoto Services, organized in 1946 as a partnership of four, is today one of the world's largest consulting firms specializing in photogeologic evaluation and detailed surface mapping. Its present staff of 100 has mapped more than 1,250,000 sq. miles of the earth's surface in the United States and 14 other countries.

Irex offices are located in Washington, D. C.; Denver; San Antonio; New York; and Calgary, Canada. Robert F.

Multiple loading with OILCO SPRING-MATIC LOADERS at a large distribution plant. Three loading platforms, loading from both sides speedily and efficiently, handle twelve transports simultaneously.

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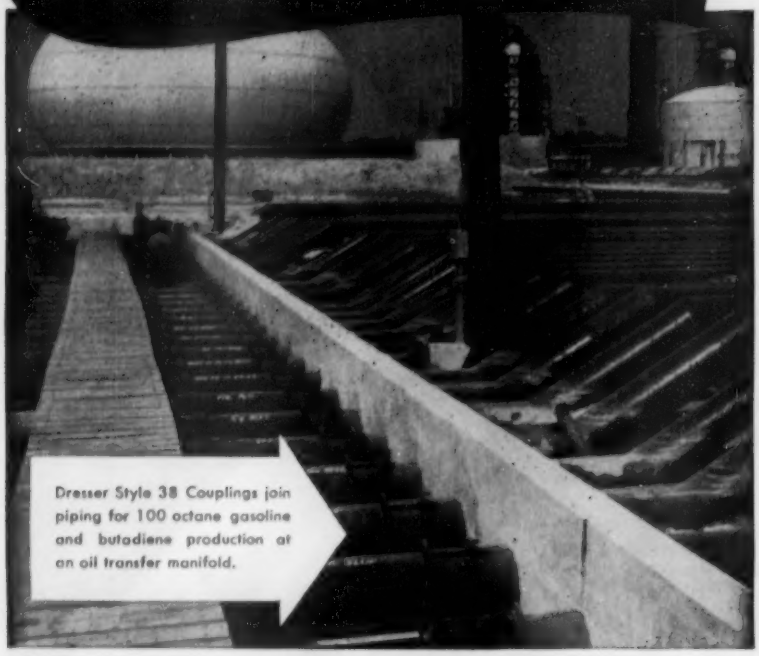

Dresser Style 38 Couplings join piping for 100 octane gasoline and butadiene production at an oil transfer manifold.

You'll find many piping applications in and around oil terminals and refineries where Dresser Couplings will simplify and speed up joining work. They're particularly advantageous for tank and equipment installations.

Dresser Couplings provide attractive features for refinery applications . . . they're easy and fast to install, bottle-tight and safe. The specially compounded rubber gasket permits up to 4° deflection at joints—yet with Dresser Couplings, these joints stay permanently tight.

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Thurrell, Jr., is executive director of the Irex Group.

LauBach Reelected Cooling Tower Institute President

N. B. LauBACH

Neal B. LauBach, manager of the cooling - equipment department of Hudson Engineering Corp., Houston, was reelected president of the Cooling Tower Institute at its annual meeting in January. Other officers elected for the 1955 terms were: Paul N. Hoffmann, Lilie-Hoffmann Cooling Towers, Inc., St. Louis, Mo., vice president; Clayton E. Pickup, Fluor Corp., Ltd., Los Angeles, secretary; and Sidney Levine, Santa Fe Tank & Tower Co., Los Angeles, treasurer.

Executive offices of the Cooling Tower Institute, trade association of the major manufacturers of industrial water-cooling equipment, are located at Palo Alto, Calif., under the direction of Raymond C. Kelley, executive manager.

Extensive field research work is carried on in the Gulf Coast area by the C.T.I. field-service department under the supervision of Chief Field Engineer James L. Willa, headquartered in Houston. Studies of wood maintenance and thermal phenomena in cooling towers are financed by the member companies of C.T.I.

Bethlehem To Construct Welded Pipe Facilities

One phase of the current $200,000,000 2-year expansion program of Bethlehem Steel Co., as announced by Chairman E. G. Grace recently, will be the installation at Steelton plant of equipment for the fabrication of welded pipe, expanded hydraulically to increase its strength approximately 25 per cent.

The pipe is made by electric welding of steel plate formed into cylindrical shape slightly under required finished diameter. In new expanding machinery which will be operating in June, large dies are clamped about the exterior of the pipe and water is forced into its interior under very high pressure. The hydraulic pressure expands the pipe to the required diameter as regulated by the dies.

The cold working of the pipe to enlarge the diameter will increase the yield strength of the steel by about 25 per cent, thereby permitting larger load-carrying capacity, and will insure uniformity of size and shape, reducing in-

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stallation time and costs. The hydraulic pressure also serves as a test to demonstrate that the pipe is leakproof. Assurance is thus provided that the pipe is safer for transmission of gas under pressure.

The Steelton plant will produce expanded pipe with wall thicknesses up to ⅝ in., to 36 in. outside diameter, and to lengths of 40 ft.

Wentworth Made General Manager, Atlas Valve Co.

The election of Harry T. Wentworth to the position of general manager has been announced by Atlas Valve Co., Newark, N. J.

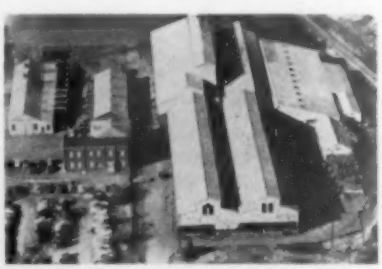
Wentworth, who, as chief engineer during the last 9 years, has been charged with designing and developing the Atlas line of temperature, pressure, and liquid-level regulating devices, will assume responsibility in the production and marketing picture as well as in the formulation and administration of future company policies.

His intensive background in valve engineering, covering more than 38 years with the nation's leading firms, has given Wentworth an unusually keen understanding of control-valve problems.

Crane Carrier Purchases Hinderliter Tool Plant

Crane Carrier Corp., manufacturer of heavy-duty truck-type carriers, has more than doubled its manufacturing facilities with the purchase of the Hinderliter Tool Co. plant, a pioneer Tulsa industry. The transaction includes six buildings and seven acres of property.

R. L. Zeligson, president of Crane Carrier, announced simultaneously with the Hinderliter purchase, C.C.C.'s plans for the manufacture of heavy-duty trucks other than carriers, including ready-mix concrete trucks, pipeline, construction, and special vehicles for well servicing, drilling machines, and the oil industry in general. Like the C.C.C. carrier, parts for these new trucks are standard, available in the United States and most foreign countries.



Hinderliter Tool plant at Tulsa purchased by Crane Carrier Corp.

Mid-Continent Supply Is Lone Star Distributor

The appointment of Mid-Continent Supply Co. as distributor for Lone Star Steel Co. oil-country tubular goods has been announced by Walter T. Moreland, Lone Star's vice president for sales.

The addition of Mid-Continent to Lone Star's list of distributors follows earlier appointments this year of Bovaird Supply Co. and United Supply & Manufacturing Co.

Lone Star owns and operates a completely integrated steel mill in Northeast Texas. Principal products are oil-country tubular goods. The company also has a foundry which produces cast-iron pressure pipe.

Axelson Expands Equipment Sales In Mid-Continent

The appointment of four additional factory representatives for the Petroleum Equipment Division has been announced by W. W. Greenway, vice president of U.S. Industries, Inc., and general manager of Axelson Manufacturing Co., Los Angeles.

L. MANNING

L. KULZER

Assigned to the Mid-Continent sales force are Leroy Manning, Leland Kulzer, Roy Grigsby, and Joe Fitts. These new Axelson factory representatives will be under the direction of Ken Ramey, sales manager for the Mid-Continent division.

R. GRIGSBY

J. FITTS

Manning joined Axelson early in 1953. However, he is well qualified in the petroleum field with experience as an oil-well puller for Union Oil Co. Before taking his present assignment, Manning was Axelson store manager at Orcutt, Calif. He is now factory rep-

Permanent color for concrete with

KWIK-COLOR

Here's a new, easy way to add *permanent* non-fading color to your concrete floors, and eliminate concrete "dusting" forever!

KWIK-COLOR SEAL: A superior concrete beautifier and preserver made from an emulsified plastic resin. Odorless, non-inflammable, water resistant, easy to apply. Dries in 20 to 30 minutes. Busy floors are back in service within 2 hours after etching, sealing and waxing. Available in Tile Red or Light Gray *permanent*, non-fading colors. KWIK-COLOR SEAL covers approximately 800 sq. ft. per gal.

KWIK-COLOR WAX: High gloss, waterproof emulsion wax for use over KWIK-COLOR SEAL to protect the seal during 14 to 20 day curing period. Highly water resistant, easy to apply. Dries in 20 to 30 minutes. Available in *permanent*, non-fading Tile Red or Light Gray colors. KWIK-COLOR WAX covers approximately 1000 sq. ft. per gal.

The combination of the right Multi-Clean Equipment and Materials with the correct procedure.

MAIL COUPON TODAY!

MULTI-CLEAN PRODUCTS, INC.
2277 Ford Parkway, Dept. OG-35, St. Paul 1, Minn.

● Gentlemen: I'd like to know more about KWIK-COLOR, also information on maintenance of:

☐ Asphalt tile ☐ Terrazzo ☐ Wood ☐ _____

☐ Send information on Floor Maintenance Equipment

Name _____ Title _____

Firm _____

Address _____

City _____ Zone _____ State _____

Killing FIRE Through Research

OPERATION FLAMES

Fire tests like that shown above are commonplace to the specialists directing operations at "Automatic" Sprinkler's Technical Laboratory and Fire Testing Department. Determining methods to lick fire before it gains headway, is their daily task.

These engineers design fire protection BEST-BY-TEST for severely hazardous manufacturing operations. All types of extinguishing mediums are at their disposal—every known method of fire detection is employed.

The services of this research phase of our business are available to our customers and potential customers. It's a service second to none in our field—lends credence to the motto . . . "Automatic" Sprinkler—FIRST IN FIRE PROTECTION!

"Automatic" Sprinkler
CORPORATION OF AMERICA
YOUNGSTOWN, OHIO

Offices in Principal Cities of North and South America

resentative in the Williston, N. D., territory.

Kulzer came to Axelson in 1949. He has accumulated a diversified knowledge of petroleum equipment working as a pump serviceman and Axelson store manager in Long Beach, Calif., and later factory representative at Taft, Calif., until his transfer. In his present position he handles sales and service in the Anson, Tex., territory.

Grigsby has been with Axelson since 1951 and has also gained experience working as a pump repairman and handling store sales. At the present time, Grigsby is specializing in hydraulic-pump sales.

Fitts joined Axelson in 1954. Prior to this time he was associated with Hughes Tool Co. as a field sales representative. He has been appointed factory representative for the Graham, Tex., territory.

Bentson Joins Sievers Co. As Chief Sales Engineer

Hal Bentson, formerly with Security Engineering Co., has joined the Sievers Co., Long Beach, Calif., as chief sales engineer. Bentson's travels will cover the United States and Canada in development of the use of Oddco drainhole equipment for hi-angle redrills, remedial redrills, and drainholes proper.

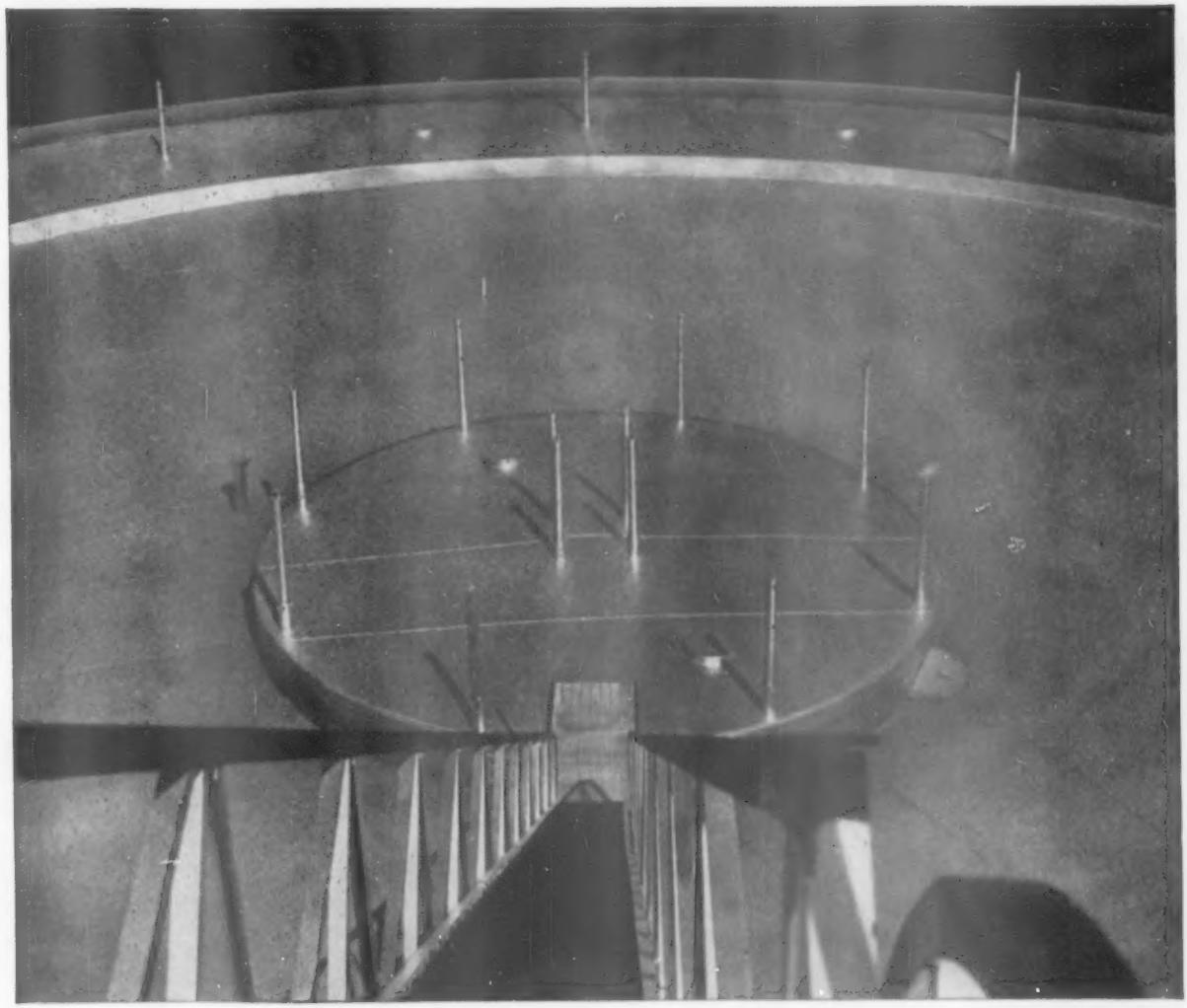
Bentson joined Security in 1938. He has worked with drilling and production tools in research, development, design, and field-engineering departments and has had considerable experience with oil-well production problems.

BrakeSol Named Distributor For McCord Chemical Pumps

L. P. BRAKE

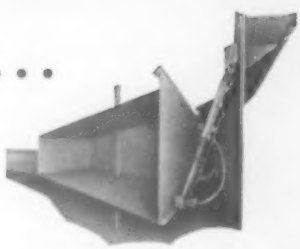
The appointment of BrakeSol, Inc., manufacturer of BrakeSol paraffin solvent, as sales and service representative for McCord Chemical Pumps and parts, has been announced by Lester P. Brake, BrakeSol president. Brake said that the pumps and parts, handled entirely through supply stores, will be serviced by Brake-Sol sales engineers.

As a new service, McCord has put in a warehouse dock at Odessa, Tex., and other warehouse locations will be



You are looking down . . .

into a Graver Center-Weighted "Floater." It's a well-built tank especially designed to conserve volatile vapors by means of Graver's own "Vapor-Stop" Seal—the improved seal which maintains firm closure between the floating roof and the shell. This patented Graver seal mechanism is an integral part of all Graver Floating Roof designs. It is flexible, yet firm—tight, yet responsive. It provides centering action for the roof and prevents the entrance of air and rain. From time to time you may expect similar technological improvements from Graver . . . where increasing emphasis will continue to be placed on research and development.



Graver's "Vapor-Stop" Seal!

The seal is free and limber, yet continues to close the gap and prevent loss of vapors. It is successful on both converted tank shells and new construction.

GRAVER

. . . a conservation design to fit every need

GRAVER TANK & MFG. CO., INC.

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CHICAGO • NEW YO.. ... ..A • EDGE MOOR, DEL.
ATLANTA • CATASAUQUA, PA. • PITTSBURGH • CLEVELAND • DETROIT
TULSA • SAND SPRINGS, OKLA. • HOUSTON • ODESSA, TEX. • CASPER, WYO. • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

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To design new oil-refineries and chemical plants. Please send your resume to our Personnel Department. Your letter will receive immediate and confidential attention.

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Engineers
Constructors
ALHAMBRA, CALIFORNIA

announced later. This is part of the expansion program of BrakeSol, which began several years ago when Brake started as a one-man organization. Now, BrakeSol has a fleet of cars and a staff of sales engineers which service users of BrakeSol in all the major oil-producing areas of the United States.

Lamond To Manage Packing Sales For Quaker Rubber

The appointment of A. J. Lamond as manager of packing sales for Quaker Rubber Corp. division of H. K. Porter Co., Inc., Philadelphia, has been announced by G. A. Dauphinais, vice president and general manager.

Lamond has 12 years' experience serving Quaker in such capacities as foreman in the belting department and assistant to the belting sales manager. He will coordinate the factory and field activities of Quaker's sheet-packing sales.

Other divisions of H. K. Porter Co., Inc., are Alloy Metal Wire, Connors Steel, Delta-Star Electric, Lacledе-Christy, Leschen Wire Rope, Quaker Pioneer Rubber Mills, McLain Fire Brick Co., Riverside Metal Co. and its Keystone Watch Case & Instrument Division, Watson-Stillman Co., and Watson-Stillman Fittings.

Parkersburg Promotes Latimer To Eastern Manager

L. R. LATIMER

L. R. Latimer has been promoted from area manager to eastern sales manager for Parkersburg Rig & Reel Co., division of Parkersburg-Aetna Corp. This change, which has been announced by A. G. Evans-Lombe, vice president in charge of sales, became effective immediately. Latimer will continue to be located at his present headquarters in Parkersburg, W. Va.

Buflovak Announces Six New Sales Appointments

James P. Beyser, vice president and general manager of Buflovak Equipment Division, Blaw-Knox Co., manufacturers of process equipment, has announced six new sales appointments.

Harold V. Williams, formerly sales manager of Blaw-Knox process equipment, has been promoted to assistant sales manager of Buflovak with headquarters at Buffalo, N. Y.

Robert H. Hazlett, formerly assistant manager of the process equipment department, has been made gas-equipment sales manager at Buflovak.

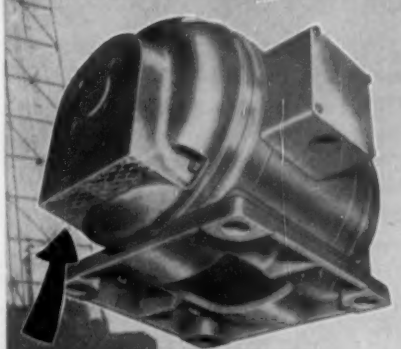
In connection with the expansion at Buflovak, E. V. Hegg, vice president and sales manager, has announced four district office appointments. Edgar L. Demarest, formerly representing the Buflovak Division at the company's New York office, has been appointed district sales manager of Buflovak at Philadelphia.

Warren V. Eisenhuth has been added to the Buflovak sales organization and is assigned to the Philadelphia office, where he will assist Demarest.

Harold R. Kibby has been promoted to sales representative of Buflovak at Birmingham, Ala., and George B. Phil-

designed especially for *continuous* outdoor use . . .

FIELDMASTER
BALL BEARING
MOTORS



More and more FIELDMASTER Ball Bearing Motors are purchased for oil field use than ever before. Here's why: These **rugged** motors are **specially built** to meet the **tough** and **varied demands** of continuous outdoor use.

For example — heavy cast base assures alignment stability . . . heavy-duty, double-shielded, pre-lubricated bearings increase performance, reduce lubrication problems . . . high-grade silicon steel in the magnetic circuit reduces iron losses . . . wide variety of windings provides triple ratings, dual voltages . . . high torque licks heavy starting problems . . . high slip is available to take care of reciprocating load requirements encountered in pumping.

The FIELDMASTER has many other **outstanding advantages** that our distributor, the BETHLEHEM SUPPLY COMPANY, will be happy to show you. May we have them contact you . . . **without obligation?**

Screened Air Port Keeps Out Rodents!

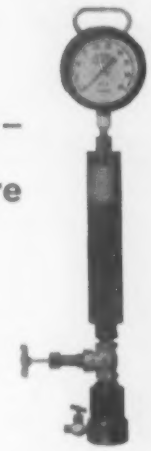
VALLEY ELECTRIC CORP. 4221 FOREST PARK BLVD., ST. LOUIS, MO.
Distributor, BETHLEHEM SUPPLY CO., TULSA, OKLA.

VICTOR *ALLOY STUDS*

VICTOR PRODUCTS CORP.
2635 W. BELMONT AVE. • CHICAGO 18, ILL.

REID VAPOR-PRESSURE BOMBS

For Either Pressure or Immersion Sampling



for testing Natural Gasoline – Benzol Blends – and other liquids not exceeding a vapor pressure of 45 lbs. at 100° F. by the Reid Method.

Construction conforms strictly to A.S.T.M. specifications. Requires no wrench—By means of the "O" ring gasket hand coupling will make a tight seal. Each bomb tested for 200 pounds air pressure.

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The most complete line of scientific instruments and laboratory supplies in the world.

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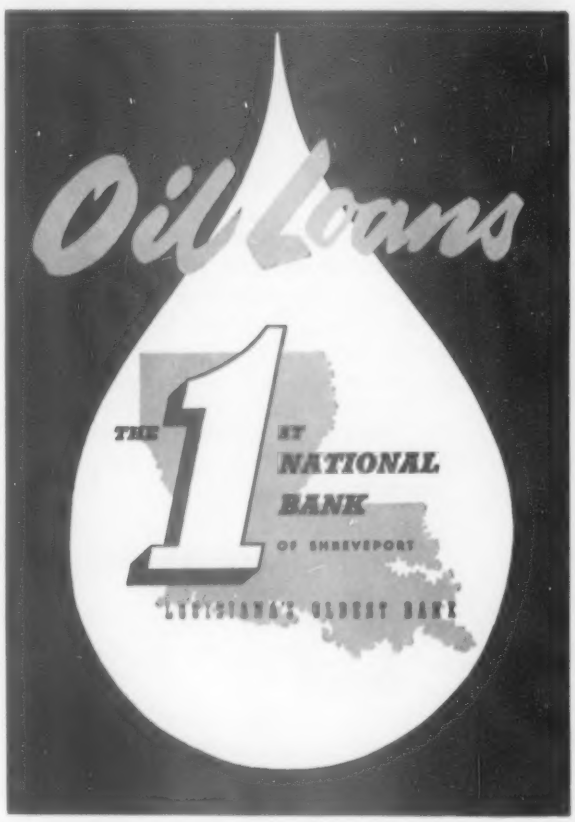
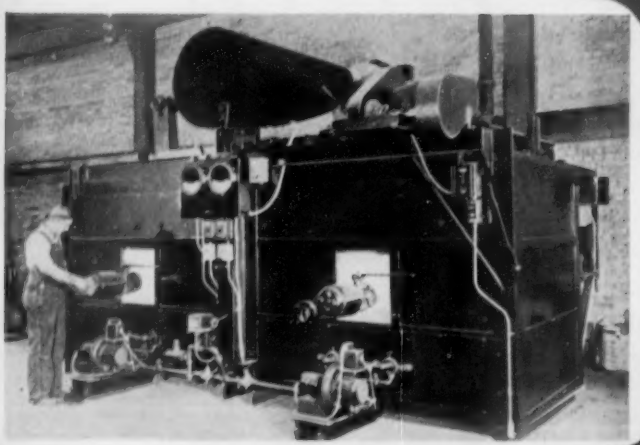
GIANT NOISE KILLER—This huge silencer is typical of many industrial and marine silencers designed and manufactured by Kittell Muffler & Engineering Company, Inc., 915 South Santa Fe Avenue, Los Angeles. Kittell silencers are available in a wide variety of standard sizes and types, including stainless steel and ceramic coated, in any quantities. Custom models engineered to meet your particular requirements. Excellent delivery. Write for catalog. *Experienced design and application engineers needed.*



Quality in the Making



How Special Equipment Like These Melting Kettles Contribute to PLS Controlled Protection

An important contribution to the uniform quality protection provided at PLS for steel pipe is the special equipment designed and built by PLS engineers. Typical are the unique melting kettles pictured above, which are gas-fired and equipped with agitators and automatic temperature controls. Combined with PLS experience, modern facilities like these make possible the finest cleaning, priming, coating and wrapping your protection dollar can buy.

DEPENDABLE SERVICE SINCE 1931

PLS Pipe Line Service Corporation

Pioneers in Steel Pipe Protection

General Offices and Plant: Franklin Park, Illinois

Plants at Glenwillard, Penna.; Longview, Texas; Corpus Christi, Texas; Harvey, La.; Sparrows Point, Md.; and Monmouth Junction, N.J.

ips has been appointed sales representative of Buflovak at the firm's Chicago office.

Williams joined Blaw-Knox in 1936 and has had an extensive background in the application and sale of process equipment. The process equipment department of Blaw-Knox, formerly located at Pittsburgh, was integrated into the expanded and modernized operation at Buflovak the first of the year.

Baash-Ross Names Messinger As General Manager

HAL MESSINGER

The promotion of Hal Messinger to general sales manager for the Baash-Ross organization has been announced by Glenn D. Johnson, general manager for Baash-Ross Tool Co., Division of Joy Manufacturing Co. His headquarters will be in Houston, where he will have charge of all domestic and export commodity sales for the company.

Messinger is well known to oil men in both Gulf Coast and California areas, having operated for a number of years as Baash-Ross sales representative, then district sales manager in the California fields, and lately as district sales manager on the Gulf Coast before his most recent advancement.

Neal Heads Region For Owens-Corning Fiberglas

James L. Neal, Dallas sales manager for Owens-Corning Fiberglas Corp., has been named the company's southern regional sales manager, it has been announced recently.

In his new post, Neal will coordinate marketing, distribution, technical services, and personnel training for the company's branch sales offices in Dallas, Atlanta, Florida, New Orleans, and Houston.

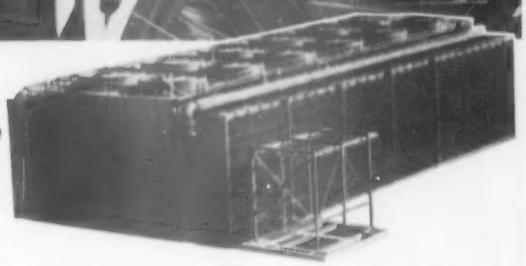
With Owens-Corning since 1943, Neal was appointed Dallas sales manager in 1946.

Climax Engine Establishes Twelve New Distributors

Climax Engine & Pump Manufacturing Co. has recently set up 12 new distributor locations to improve service to Climax engine users.

The new distributors are: Sweeney

He tests his purchases...



Do you?

Cooling tower owners, too, turn up some surprising test results — as you will discover when you follow the simplified testing procedure described in a new Marley technical publication, "Test Your Tower".

You may be astounded, for example, with the difference between your tower's actual performance and the performance "guaranteed" by the manufacturer. Or, if you have a tower that was purchased with plant expansion in mind, a test now may reveal that the future performance you are counting on is purely theoretical — that it won't be there when you need it.

But whatever your situation, it will pay you to test. And "Test Your Tower" makes testing simpler, more direct, and more accurate than ever before. Get your free copy right away — by mailing the coupon below or calling the Marley representative in any of fifty major cities.

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MARLEY

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The Marley Company

Kansas City, Missouri

Technical Services Dept.
The Marley Co.
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Kansas City, Mo.

Please send me a copy of your new brochure, "Test Your Tower."

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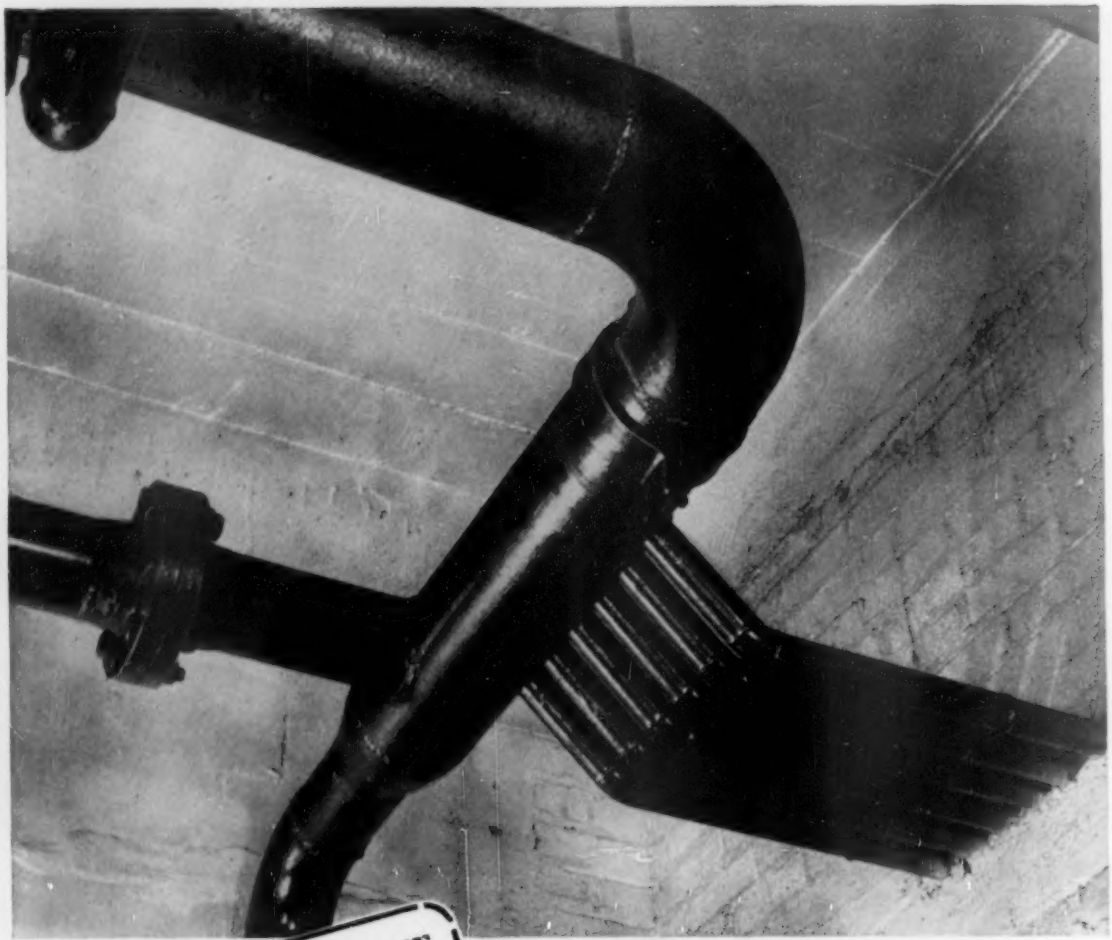
How to Tame a Tough Joint



ANOTHER JOB DONE BETTER WITH GLOBE WELDING FITTINGS

KEEP an eye on the future when you install piping—even the most innocent looking connection can become a "tough joint" through leakage — pressure-loss — the focal point for erosion and corrosion — constant maintenance time and cost.

You can tame probable "tough joints" in piping by making connections with permanently tight, leakproof Globe Welding Fittings. Strength is forged in the fittings — flow friction and pressure-loss minimized by precision formed true angles, radii, circularity—weight and space requirements reduced—exact dimensional accuracy that saves time, speeds piping assembly. To do any piping job better — use Globe Precision-Process Welding Fittings.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Fittings Department
3839 W. Burnham St. • Milwaukee 46, Wisconsin

B&W SEAMLESS and WELDED TUBES

Brothers, Williston and Fargo, N. D.; Cullander Machinery Co., Belzoni, Miss., and West Memphis, Ark.; Equipment Service Co. (irrigation engines only), Pecos, Tex.; Henkle & Co. (irrigation engines only), Garden City, Kans.; Landes, Zachary & Peterson, Denver, Billings, Mont., El Paso, Tex., Albuquerque, N. M., Casper, Wyo., and Salt Lake City, Utah.

This makes a total of 30 Climax distributor locations throughout the country. Climax manufactures gas engines for use in oil field, cotton gin, irrigation, and other industrial service.

Tompkins Joins Western As Administrative Assistant

L. L. TOMPKINS

Lee L. Tompkins has been appointed administrative assistant to John F. Younger, vice president of research and development for Western Co., technical oil-well servicing concern with headquarters at Midland, Tex. Prior to joining Western Co., Tompkins was training director for a major chemical company in East Texas for 4 years, and before that, was assistant division manager in a large manufacturing concern at Chicago.

In his new position with Western, Tompkins will plan and coordinate methods and procedural work in the research and development division. His headquarters will be in Midland.

Castelan Joins Sweco's Los Angeles Refining Group

R. F. Castelan has recently joined the refining division of Southwestern Engineering Co. at Los Angeles.

Castelan is handling Latin American sales for SWECO and is presently on an extended trip through Mexico to be followed later by trips to various South American countries.

American Cyanamid Names Keppler to Sales Post

R. G. Keppler has been appointed technical sales representative for the refinery chemicals department of American Cyanamid Co., it has been announced by R. E. Sumner, manager of the Industrial Chemicals Division. He will be located in Houston.

Keppler joined Cyanamid's refinery chemicals department in 1953 as a senior technical representative and coordinator.

LELAND "PACKAGED UNIT"

•

LELAND POLE TRAILERS

•

LELAND SELF-LOADING FLOAT SEMI-TRAILERS

•

LELAND TANDEM SELF-LOADING FLOATS

•

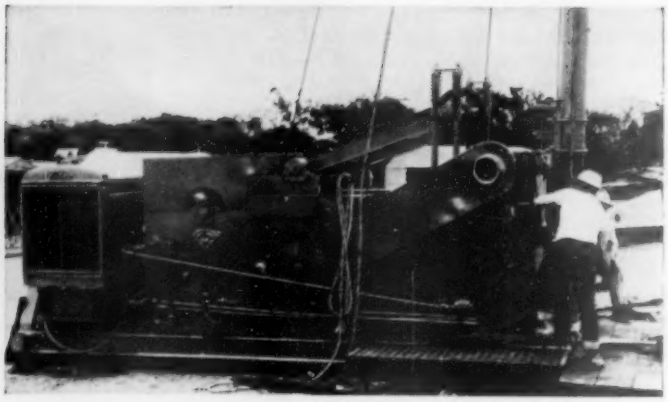
TULSA WINCH Equipment, Parts, Service

Within the past few years everyone's operational costs have been soaring. It's twice as foolish therefore to buy truck bodies that break down in the field . . . show excessive wear under strain . . . endanger your personnel — in other words, *do half the job for which they're intended!* Through close contact with the man in the field the Leland Equipment Company designs and manufactures the Leland "Packaged Unit" oil field truck body . . . a body that does the *whole job* each day, every day, year after year. Into each "Packaged Unit" goes the best engineering skill, materials, and fabrication excellence. Users are amazed at the versatility of this superior body. It performs with equal dexterity and safety on hauling . . . gin pole winching . . . straight winching jobs. Each "Packaged Unit" is equipped with gin poles. Your winch or a heavy duty Tulsa Winch supplied by Leland can be mounted quickly and easily at your option. Get the full details . . . write for Leland's new pamphlet, "The Leland Packaged Unit".

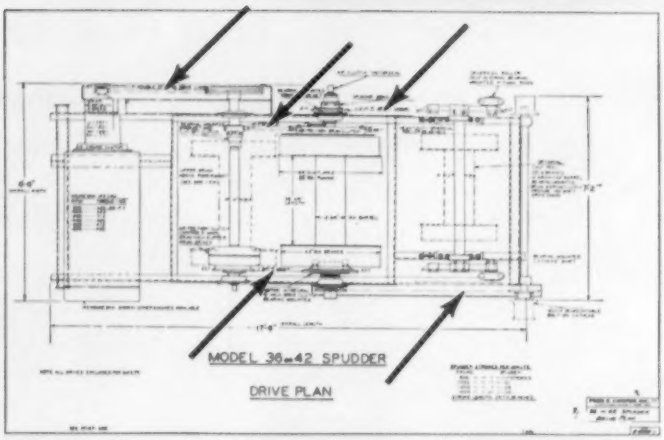
Leland
EQUIPMENT COMPANY
Oklahoma City • TULSA • Longview, Texas

ON THE NEW

Fred E. Cooper, Inc. SPUDDER



DIAMOND ROLLER CHAINS



For maximum drilling speed the new Cooper "42" tailing-in Spudder illustrated has a spudding action that drops tools fast—and there's power for fast bailing, swabbing and rod and tubing work.

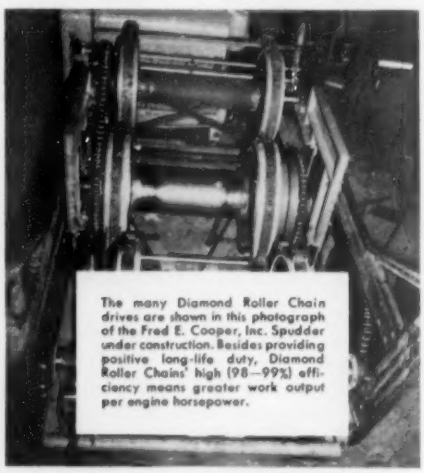
As on leading oilfield equipment everywhere, this Fred E. Cooper, Inc. Spudder is standard equipped with Diamond Roller Chains.

The reasons are clear—Diamond Roller Chains provide longer, better service and require less maintenance. Manufacturers who stress quality in the products they make know that to sacrifice quality in component parts is false economy.

For *your* Roller Chain applications, specify Diamond—their uniform high quality is assurance of performance and economical operation on the toughest of jobs.

ALWAYS PRELOADED

For many, many years, Diamond Chain has been preloaded after assembly for the purpose of bringing pin-bushing seating into stabilized relationship prior to field installation.



The many Diamond Roller Chain drives are shown in this photograph of the Fred E. Cooper, Inc. Spudder under construction. Besides providing positive long-life duty, Diamond Roller Chains' high (98—99½) efficiency means greater work output per engine horsepower.

DIAMOND CHAIN COMPANY, Inc.

Where High Quality is Traditional

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Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

DIAMOND ROLLER CHAINS

EXPLORATION

The Third Time Is a Charm

by Norman S. Morrisey

GEOLOGISTS have long suspected that the complex producing trends in southern Oklahoma are related to similar trends in Grayson County, Texas. However, these trends are separated by a barren area where well control is sparse. Frankfort Oil Co. has cut this gap from 30 miles to less than 15 miles with its 1 Conrad, a deep test in North Marietta pool.

The 1 Conrad drilled through the Viola limestone three different times and is currently testing 10 bbl. of oil per hour from the deepest Viola section. It is unusual for wells to drill the same bed several times, although it does happen in complex trends. But it is more unusual to get production from a zone that is encountered three different times.

Repetition of a bed can mean reverse or thrust faulting. This occurs in intensely folded and faulted belts.

The producing trends in Carter and Love counties, Oklahoma, may eventually link up with similar trends in Grayson County, Texas.

Complicated trends . . . In Oklahoma, the surface outcrops south of Ardmore can be mapped. The area is a puzzle to even the best geologists because of the complexities, but several prominent anticlines have been outlined like Overbrook and Rock Crossing. To the southeast and in Grayson County, Texas, Cretaceous beds mask the underlying structures; geologists can only infer what has occurred from limited well control. Grayson County has several fields that have complicated geology similar to the Oklahoma surface structures. Sandusky in northwest Grayson County is a good example.

Because of the similarity of the two producing areas, the trends may be related and eventually join up. The Frankfort 1 Conrad appears to be on the trend and has cut down the distance between the trends to less than 15 miles.

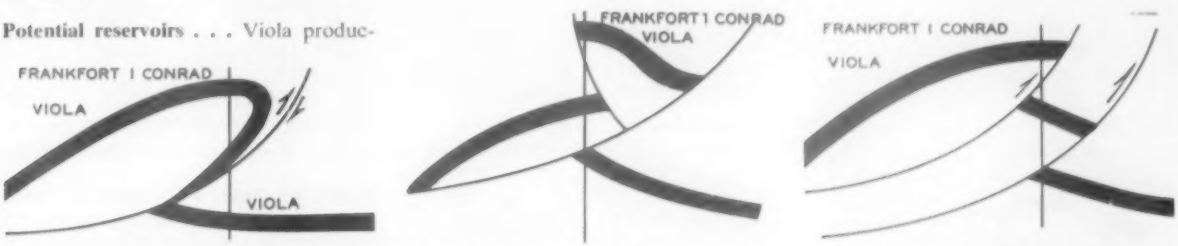
Potential reservoirs . . . Viola production along the trend is highly encouraging, but oil companies are more interested in the deeper pays of the Simpson formation. These sands are prolific reservoirs in southern Oklahoma; in Grayson County, Texas, the Oil Creek sand (Simpson) is an excellent pay and produces in several fields.

The question arises, are the Simpson sands present along the trend in southern Oklahoma? There is not enough well control at the moment to answer the question. Two schools of thought exist concerning Simpson possibilities along the southern Oklahoma part of the trend. One group condemns the area because of poor sand development. The other group is more optimistic and points to the well-developed sands at Cumberland, North Madill, and Sundusky. They consider that some of the Simpson sands are blanket sands and cover a wide area; these sands will eventually produce over a much larger area than they do at present.

More deep tests are needed to explore the Simpson possibilities.

North Marietta geology . . . Complex folding and faulting must exist at North Marietta to account for the Frankfort 1 Conrad. Several interpretations can be advanced to explain the repetition of the Viola limestone. Sketches below show three different solutions, but other solutions are possible.

Regardless of the interpretation, it is obvious that Frankfort has opened up new possibilities along the southern Oklahoma fault trend with its 1 Conrad.



Geological sketches show how a well may drill the same bed three different times. Such conditions occur in complexly folded and faulted areas.

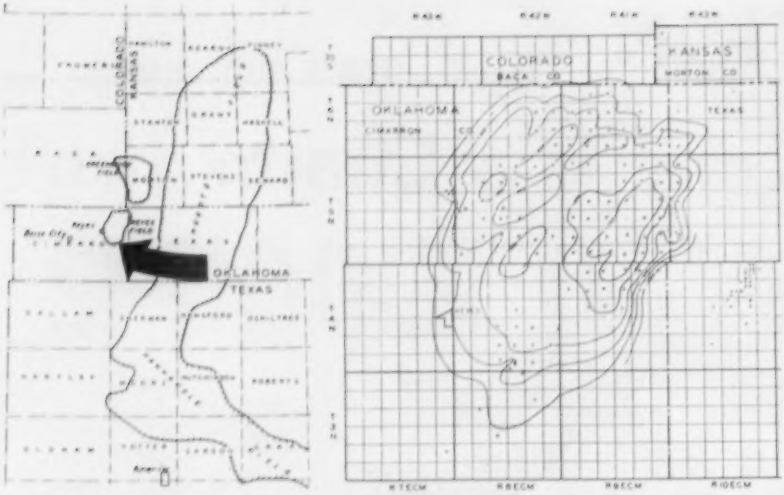


Fig. 1—Keyes gas field, Cimarron County, Oklahoma, lies just west of the Hugoton field (left). Structure map on right is contoured on top of the Keyes (basal Pennsylvanian) sand. Contour interval 50 ft.

Oklahoma's Keyes Field May Cover 85,000 Acres

by C. Richard Wagner

KEYES gas field in the Oklahoma Panhandle now covers 57,160 acres. Present data indicate that an additional 28,800 acres will be productive if the Keyes sand is present.

Limits of the Keyes field should expand as drilling continues (Fig. 1). On February 1, 1955, there were 89 gas wells and 10 oil wells producing from the Keyes (Morrow) sand. Several other pay horizons are indicated in addition to the Keyes sand. Thus far, the younger Morrow sands have been lenticular and the reservoirs cover only a limited area.

Author is geologist with Harrington, Marsh & Wagner, Amarillo, Tex.

Keyes gas field is in the northeast corner of Cimarron County, Oklahoma, near the town of Keyes; it is 15 miles northeast of Boise City, the county seat of Cimarron County (Fig. 1). The western edge of giant Hugoton gas field, producing from the Chase group (lower Permian), is approximately 15 miles to the east.

The discovery well, Pure Oil Co. 1 R. E. Cox, SE SW SE 16-5n-8eCM, was located after an extensive core-drill program. The well was bottomed at 6,280 ft. in pre-Cambrian basement complex. After testing water in the Arbuckle and Mississippian, it was plugged back to 4,770 ft. and completed in May 1943 as a gas well from perforations (4,684-4,735 ft.) opposite basal Morrowan sand (Keyes sand). The natural initial open-flow potential was 19,300,000 cu. ft. of sweet, dry gas per day. Shut-in pressure was 850 psi. and the gas had a B.t.u. rating of approximately 825.

During 1945 and 1946 Pure Oil Co. completed 14 wells with a record of 5 small oil wells, 4 gas wells, and 5 dry holes. All wells produced from the Keyes sand. The area was quiet until early in 1953 when an active development program was started. This was stimulated by the discovery of a high-B.t.u. gas reservoir in an upper Morrow sand, approaching lease expirations, and a potential market for the gas.

Prior to 1943, exploratory effort in the area had largely been confined to the lower Permian beds which produced gas in Hugoton field and oil and gas in Panhandle field. At that time there were only a few widely scattered tests which had penetrated pre-Pennsylvanian horizons. The 1 Cox was the first producing well completed in a lower Pennsylvanian bed. This discovery caused an extensive lease campaign west of the boundary of Hugoton field and stimulated exploratory drilling which has led to the discovery of additional gas reserves in Pennsylvanian horizons.

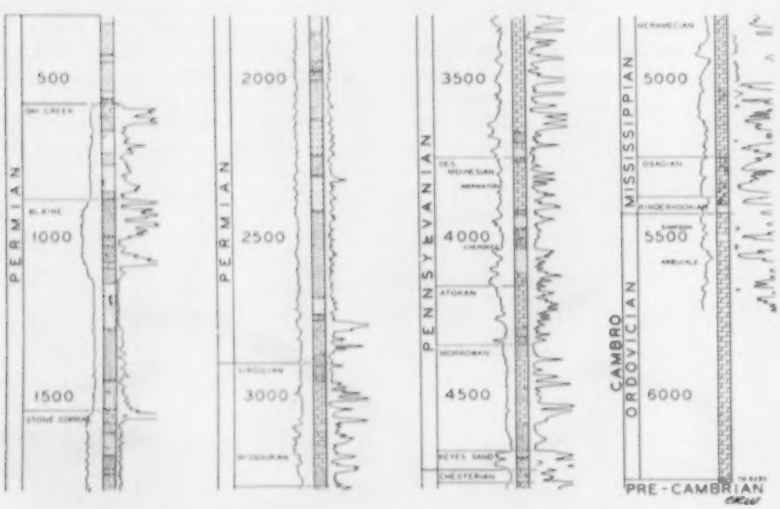


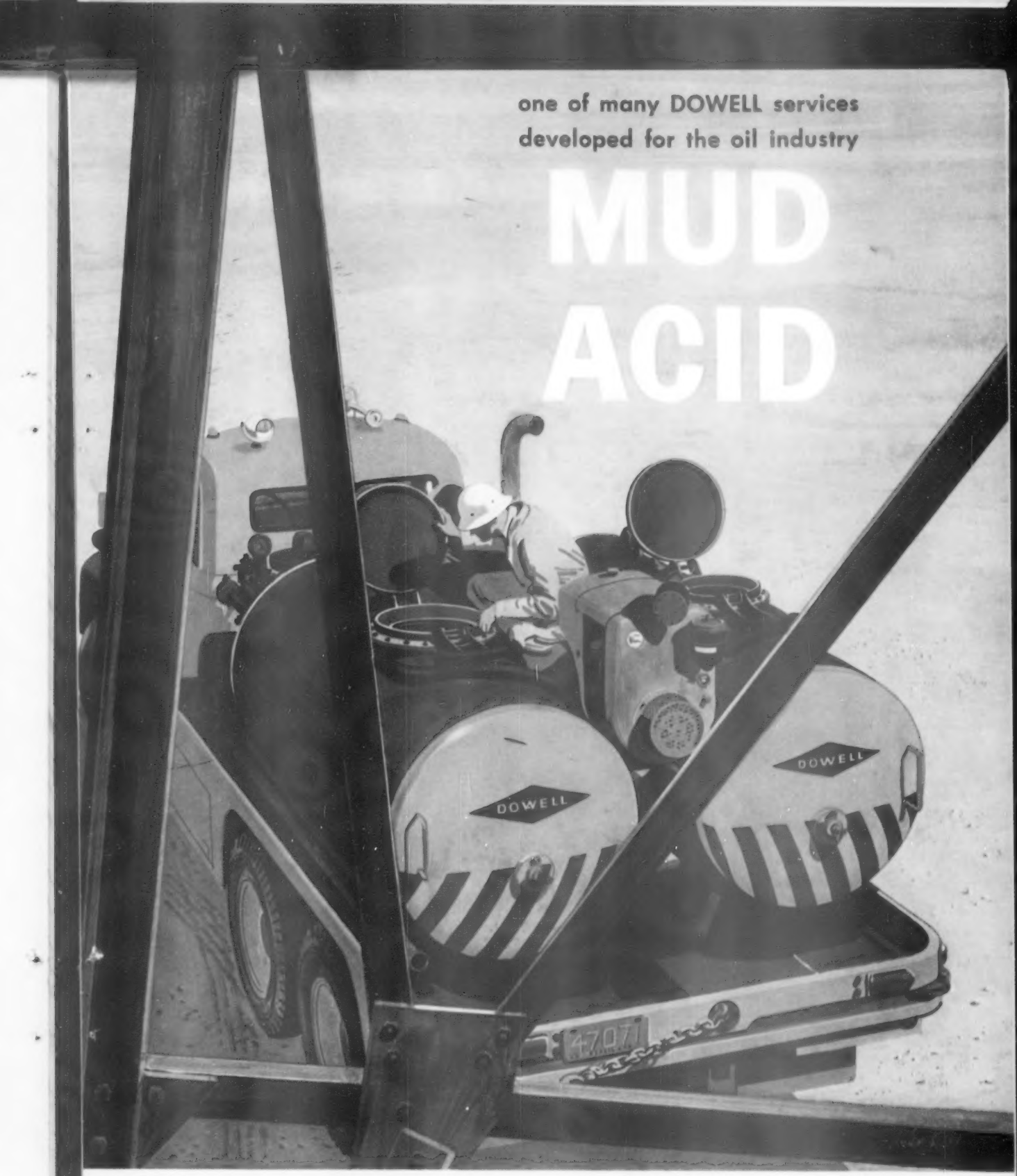
Fig. 2—Generalized columnar section of Keyes gas field.

Stratigraphy

It is difficult to correlate exactly the Pennsylvanian section farther to the east with the section in Keyes field. More exact correlations should be possible as additional control and paleontological data are available. The subdivisions used are therefore questionable and subject to change. Fig. 2 shows a generalized stratigraphic column based on the discovery well which is the only well in the field to have penetrated the complete sedimentary section.

Beds of Pennsylvanian age vary in thickness from 1,800 to 2,000 ft. and are substantially thinner than to the east and southeast. All units with the exception of Springer are represented.

Producing zones . . . Morrow sands, with one exception mentioned, are the only proven reservoirs and the basal or Keyes sand is the primary objective



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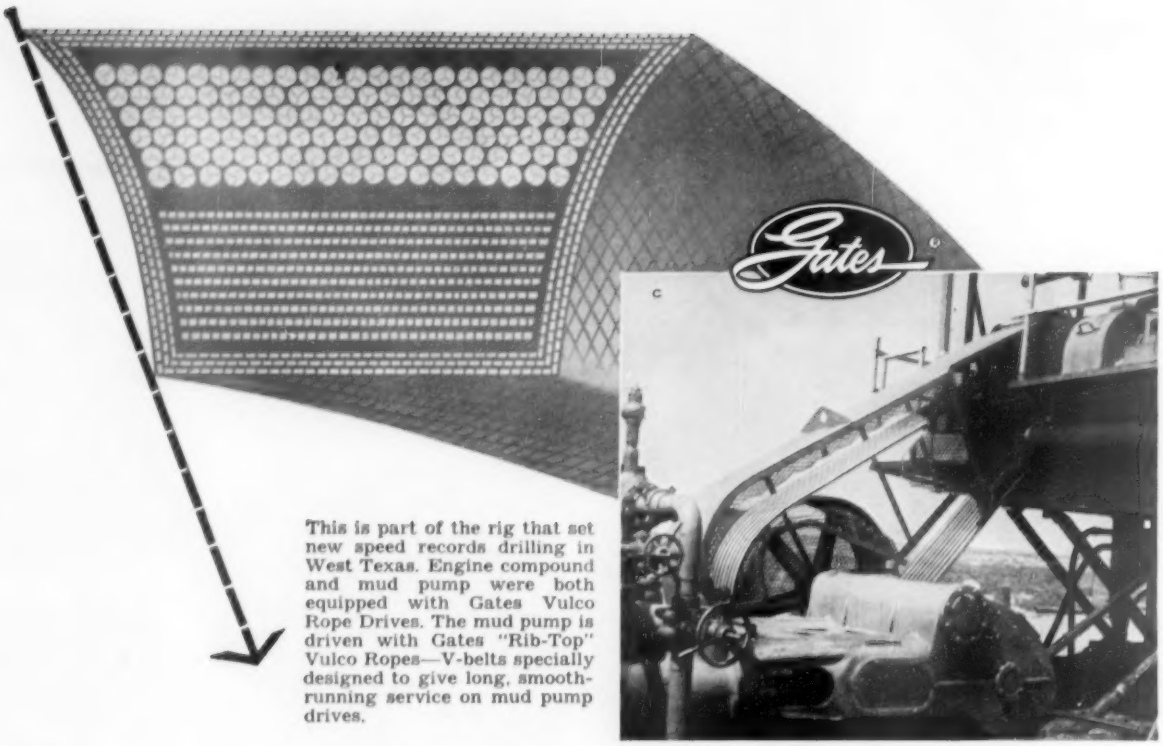

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Bend a straight-sided belt (Fig. 2) and feel the sides *bulge out* around the bend. The bulging sides prevent the belt from fitting evenly in the pulley groove (Fig. 2-A). Uneven contact causes uneven wear...shortens belt life...increases costs.

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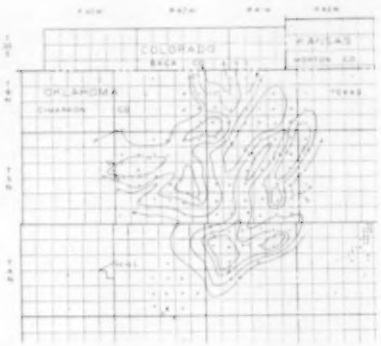


Fig. 3—Isopachous map of the Chester series (contour interval 20 ft.).

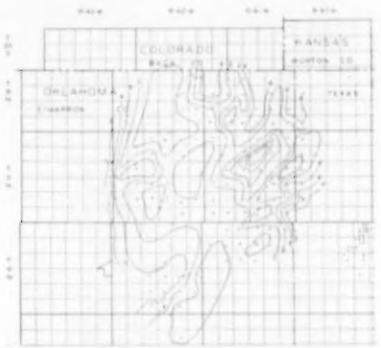


Fig. 4—Isopachous map of the Keyes field (contour interval 20 ft.).

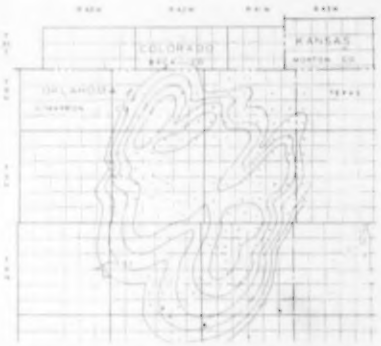


Fig. 6—Structure map of Keyes field contoured on top of the Meramec (Mississippian). Contour interval 50 ft.

(Fig. 2). Oil and gas occur in a number of apparently separate sands younger than the basal sand. These sands are lenticular and are considered to have a limited areal extent. It is suggested that they are similar to the shoestring sands of eastern Kansas and northeastern Oklahoma.

The Keyes sand is an unconformity deposit present at the base of the Morrow. It rests unconformably on the underlying Mississippian, usually Chester. Its presence in most wells in southeastern Colorado, southwestern Kansas, Cimarron County, Oklahoma, and Dallam County, Texas, suggests that the sand is a blanket deposit over a large area.

In Keyes field, the sand is a fine to quite coarse subangular to subrounded calcareous, glauconitic quartz sand subject to rapid lateral variations in thickness and lithologic character. Porosity and permeability of the sand are quite variable. Limited core-analysis data indicate that the porosity averages about 13 per cent. Permeability varies from zero to as high as 5,000 md., and in most wells probably averages more than 100 md.

Thickness of the sand varies from a few feet to a maximum of 126 ft. including shale streaks. Sand is present in all wells in the field though in a few wells the sand development was insufficient to permit completion of commercial wells. Normally only one or two sands are present though as many as four sands are known to occur. In most wells only the two upper sands have been productive of oil or gas.

The Keyes sand was deposited on the Mississippian erosional surface. Fig. 3 is an isopach map of the Chester, which normally underlies the Keyes sand. The map shows a number of thin Chester areas. Comparison of this map with the structure map on top of the Meramec (Fig. 6) indicates that part of the areas of thin Chester corresponds to anomalies mapped on this horizon. Fig. 4 is an isopach map of the Keyes sand. Comparison of this map with the Meramec structure map (Fig. 6) suggests that the areas of thin sand deposition are related to the structurally positive areas.

If it is assumed that at the end of Keyes sand deposition the surface was essentially level, thick sand deposition should occur in the lows and a thinning of the sand across the highs. These conditions are suggested by the cross-section of a portion of the field (Fig. 5). It is believed, therefore, that deposition of the sand was controlled by a combination of Mississippian structure and topography. Normally the sand appears to lap out on the structural and topographic highs present at the beginning of Morrow times; only a thin veneer of sand is present where these highs occur.

Structure

Keyes field is near the western edge of the Hugoton embayment. To the west lies the Sierra Grande uplift and to the south the Dalhart basin which is probably a westward extension of the Anadarko basin. Keyes field is the highest portion of a northeast-southwest structural trend extending from southwestern Morton County, Kansas, in a southwesterly direction across Cimarron County, Oklahoma. This trend of folding is near the eastern margin of a structurally high area that borders the Hugoton embayment and extends westward towards the east flank of the Sierra Grande uplift.

Keyes field appears to consist of a series of low-relief folds with a northeast-southwest alignment. The closure on local folds is small though regionally there is a substantial amount of relief on the feature. Present data suggest that the structures are affiliated with trends of folding.

Structure on top of the Keyes sand and base of the sand are similar though variations in sand thickness are responsible for some deviations. To a degree these maps are affected by Mississippian topography. A map on top of the Meramec (Fig. 6) is the only one which can be regarded as reflecting the structure since this horizon has been least affected by truncation.

Present evidence suggests several periods of recurrent gentle folding. Certainly the area was uplifted prior to Morrow times. Thinning of Morrow, Atoka, Des Moines, Missouri, and Vir-

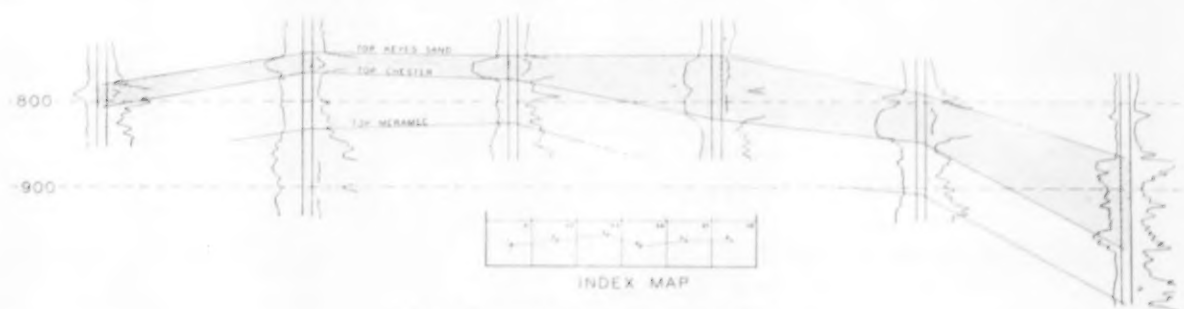


Fig. 5—East-west cross-section across Keyes field.

gil beds compared to areas to the east suggests gradual movement throughout the Pennsylvanian. Locally there appears to be considerable variation in the Des Moines suggesting a post-Atoka movement of greater intensity. Since the structure exists in Permian beds a post-Permian movement is inferred. At the close of Laramide times the area was tilted to the southeast.

No positive proof of faulting exists. Steep east dips along the east side of 4n-9eCM may be indicative of faulting, but this cannot be proved at this time. Faulting, if present, probably represents tensional relief caused by settling of the Hugoton embayment with respect to the positive structural areas to the west.

Production Characteristics

Accumulation in the Keyes sand is considered to be due to structure although locally stratigraphic factors may be partly responsible. The sand has approximately 200 ft. of productive closure. In the top member of the Keyes sand the gas-oil contact is at or near a datum of 890 ft. below sea level and the oil-water contact is 930 to 940 ft. below sea level. In second sand the oil-water contact is approximately 900 ft. below sea level and no definite gas-oil contact has been established. In most instances sands below the top two members are found too low structurally to produce. It is doubtful if there is any major accumulations of oil in the sand because the oil column is so thin. The Keyes sand is therefore essentially a gas reservoir. Because of the lack of structural relief on individual folds the accumulation is attributed to regional structure.

All gas found in the Keyes sand has a high inert content, approximately 26 per cent, and a low B.t.u. rating (800 to 825). Some wells produce minor amounts of condensate along with the gas. The shut-in pressure of the wells is approximately 850 psi. Oil occurring in the Keyes sand varies from 29° to 40° B., has a high paraffin content, and a pour point at or near 59° F.

Since none of the wells have been produced long enough to set up pressure-decline curves, an accurate estimate of the reserves is not possible.

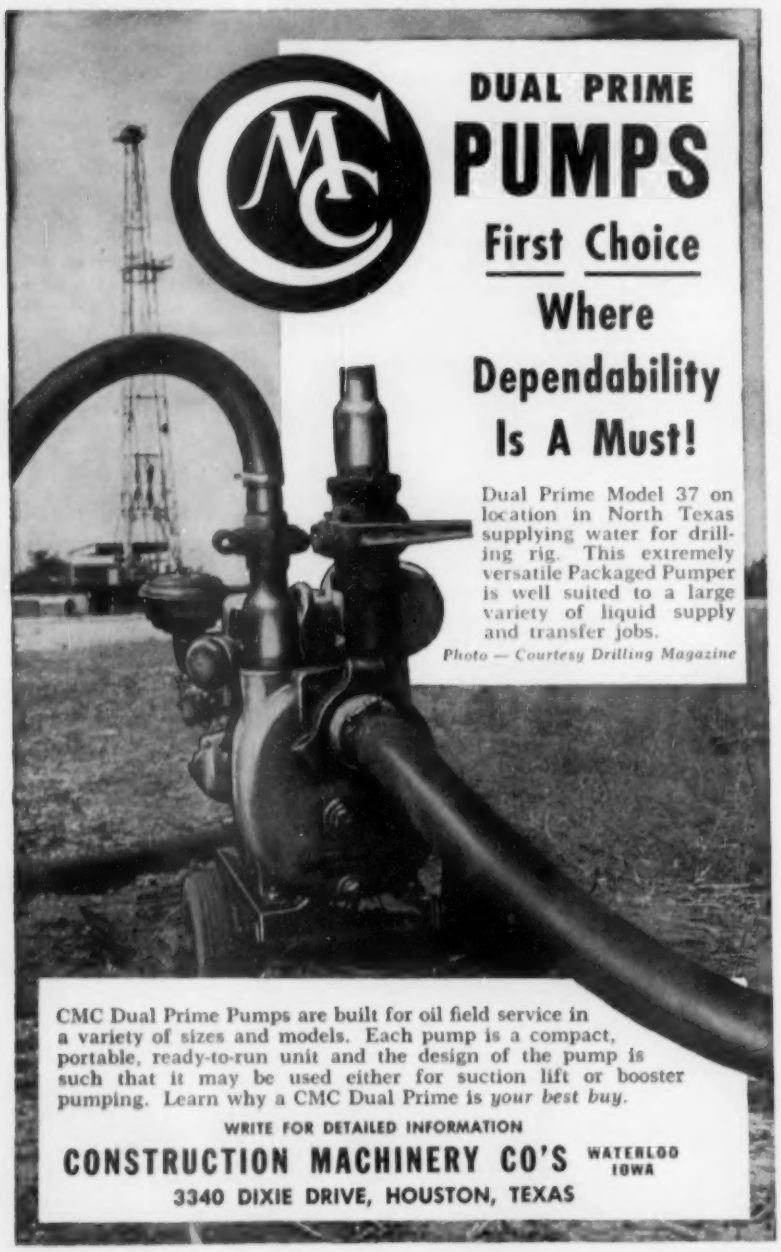
Above the Keyes sand there are younger Morrow sands that produce oil or gas. These sands are lenticular and the individual reservoirs have a limited areal extent. The Coltex Corp. Purdy 1-E, 17-6n-9eCM, was the first well in the field to be completed as an oil producer in one of these sands. During 1954, Cabot Carbon Co. completed four oil wells from upper Morrow sands in 30-5n-10eCM. Normally the gas from these post-Keyes sands tests approximately 1,050 B.t.u.'s and the shut-in pressure is about 1,050 psi. The oil is highly paraffinic and has a gravity of 40° B. Future drilling should lead to the discovery of additional reserves in similar sands in the field and the immediate area.

One well, Colorado Interstate Gas Co. 1 Whisennand, tested a small volume of gas in what is considered to be a basal Atokan sand. The gas had a B.t.u. rating of 840 and a shut-in pressure of approximately 820 psi. No wells have been completed in Atokan sands and accumulation in this zone will in all probability be erratic.

Development

Present practice is to cement surface casing at a depth of approximately 500 ft. and to set the intermediate string near the top of the Neva. Some operators set surface casing in the Stone Corral and circulate cement to the surface. Either 5½ or 7-in. casing is set through the Keyes sand. The pay zone is perforated and the well treated if necessary. Considerable lost-circulation material is carried in the mud from 3,000 ft. to total depth. Electrical surveys are standard practice. Normal drilling time averages 16 to 25 days per well.

The principal acreage owners in the field are: Colorado Interstate Gas Co.,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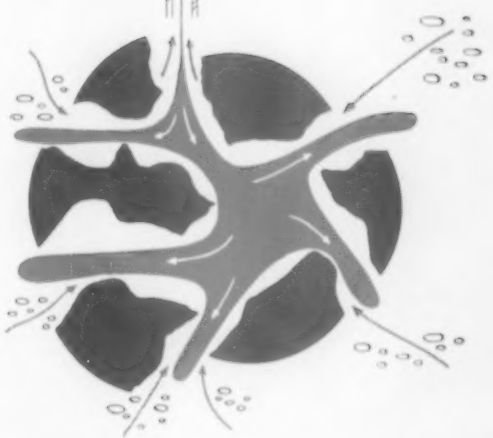

Water-oil emulsions near the well bore will often increase fluid viscosity from 10 to 2,000 times that of oil in place and create more resistance to flow than formation pressure can overcome. But doubly effective MCA, Halliburton's economical Mud Cleanout Agent, has the double action required to break the viscous emulsions that can slow down or shut down production!

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Thousands of MCA treatments in low production wells have proved its double action for opening flow channels into the well bore. And only a small quantity of MCA—500 gallons for initial treatment in the average new well—is required for the production-boosting results that have made MCA the economical stimulant for old and new wells. For proved help with economical double action, call for MCA from your local or district office of the Halliburton Oil Well Cementing Company.

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Cities Service Oil Co., Columbian Fuel Corp., United Producing Co., Superior Oil Co., and Shell Oil Co. The field is being developed under the rules of the Oklahoma Corporation Commission which stipulate one gas well to each section. At this time Colorado Interstate Gas Co. is the only outlet for the gas.

Exploration Highlights

MID-CONTINENT

OKLAHOMA

State Ending First Quarter With Excellent Success

Exploratory and development drilling in Oklahoma during the first quarter of 1955 has proved itself to be highly successful. All sections of the state report excellent success in field discoveries, deeper pays, and extensions. Lincoln County in central Oklahoma, for many years a leading state producer, continues to keep itself on top with the Cleveland sand an important new stimulus. The Viola lime is the center of attention in southern Oklahoma. Cleveland County's interest is focused on a new Wilcox pool in 27-9n-1w. The prospects of the new West Chitwood pool in Grady County are excellent. North Madill field in Marshall County, southern Oklahoma, has been extended successfully. The Northwest Lindsay area of McClain County is developing with good results.

Lincoln . . . The Cleveland sand holds the spotlight in this central Oklahoma area. New pools have been established in 19-15n-5e, 8-14n-4e, and 1-13n-2e. The best success is reported in Sweet Home pool, 15n-3e, and in Sunflower, 14n-2e. Logan County has a new Cleveland sand pool in 11-19n-2w.

Rich Oil Co. worked over an old wildcat in SW SW SE 19-15n-5e. The well flowed 44 bbl. of oil in 1 hour from the Cleveland sand at 2,806-32 ft. At another well in NW NE SW 8-14n-4e, the operator got 30 bbl. of oil per hour. Nadel & Gussman opened a new Cleveland sand pool in SE NW SW 1-13n-2e. This too was a worked over well. It flowed 202 bbl. of new oil following treatment at 3,738-52 ft.

Carter County . . . The Viola lime has put new emphasis on Carter County development. Frankfort Oil Co. recently opened a new Viola reservoir on the south end of Lone Grove field. The

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Superior in performance to any similar bit available, the new Hawthorne Insert Rock Bits have special quality, self-sharpening tungsten carbide inserts on cutting surfaces to keep the bit sharp while drilling the harder formations. High toughness of these inserts minimizes breakage, and a unique dressing process produces the superior cutting edge which assures faster penetration, cleaner hole . . . making a hole in three minutes possible.

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well, located in 12-5s-2w, had an average flow capacity of 50 bbl. hourly at 5,500 ft.

Sun Drilling Co. got a good flowing Viola well in 1-5s-2w. Development drilling in the area is picking up considerable speed and success.

Cleveland County . . . Two areas in this south-central county are active . . . 27-9n-1w and 19-7n-1e.

Ohio Oil Co. has a new Wilcox sand pool at 1 Heims, NW SW NE 27-9n-1w. This second Wilcox pool-opener flowed 190 bbl. of oil daily on 11/64-in. choke on test of open hole at 6,982-98 ft. The well made 11 bbl. hourly on 9/32-in. choke on final flow test.

West Helsel pool in 7n-1e has a new producing horizon, the Simpson dolomite. Ashland Oil & Refining Co. made the discovery at 1 Cassell, NE NW SW 19-7n-1e. A drill-stem test recovered 2,500 ft. of clean oil in the Simpson at 6,950 ft. However, the well was completed at 6,983-85 ft. flowing 420 bbl. of oil per day on small choke from the Wilcox sand.

Grady County . . . The Texas Co. 1 Gray in SE SE 24-5n-7w, West Chitwood pool, flowed 453 bbl. of oil in 12 hours from the Deese sand at 9,285-9,300 ft. The well improved greatly the prospects of this area. Other companies have begun drilling nearby.

North Madill . . . Success follows this excellent new pool in a very important area of southern Oklahoma.

Sinclair Oil & Gas Co. has extended the field's producing limits 1 mile from other production. The well, SE NW SE 15-5s-5e, flowed 995 bbl. of oil per day from perforations at 6,138-6,303 ft. The field has six producing zones.

Northwest Lindsay area . . . Good development results are reported in this area, 17-5n-4w. Wells in the developing area have flowed more than 50 bbl. of oil hourly with good gas volumes from the deep Simpson sands below 10,000 ft.

West Extension at Northeast Bradley Flows Oil on Test

A flowing drill-stem was reported at Superior Oil Co.'s 1 State, C SE SE 2-5n-5w, Northeast Bradley field well in Grady County.

Oil flowed at 37 bbl. per hour plus 2,334 M.c.f. of gas on test at 13,244-13,365 ft. in the Tulip Creek. Recovery was 728 ft. of 44.6°-gravity oil and 135 ft. heavily oil and gas-cut mud.

Bradley . . . Gulf Oil Corp. 1 Hall in SW NE 24-5n-5w, flowed at the rate of 35 bbl. per hour and 2,700 M.c.f. of

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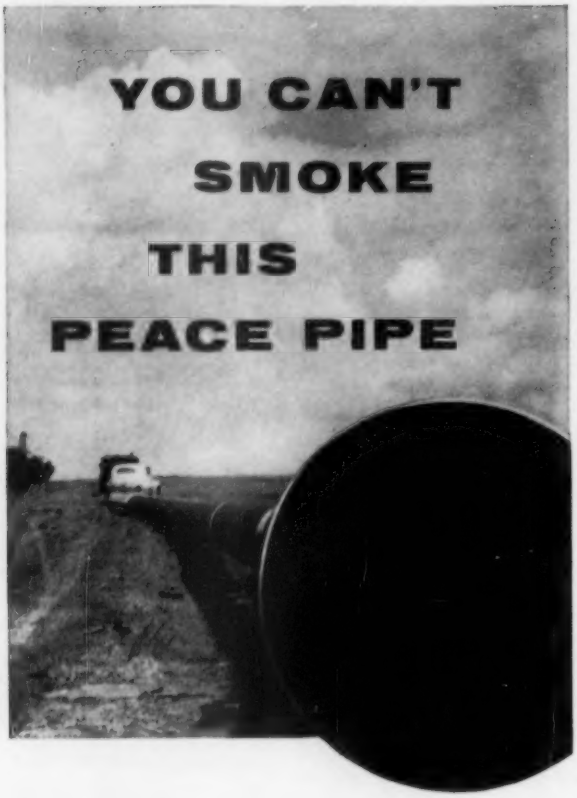

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These are but a few of many improvements and enlargements in Cities Service operations...some for competitive advantage, some for cooperation with the entire industry and the government. They clearly reflect the progress that can be made in a business society whose members know that competition and cooperation are not incompatible.

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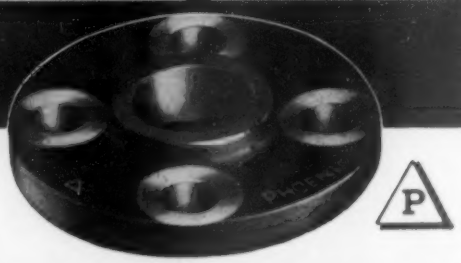

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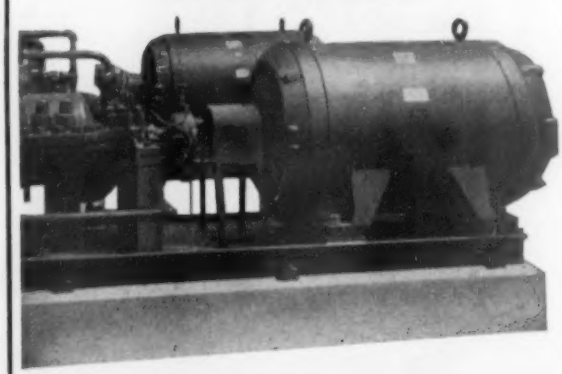

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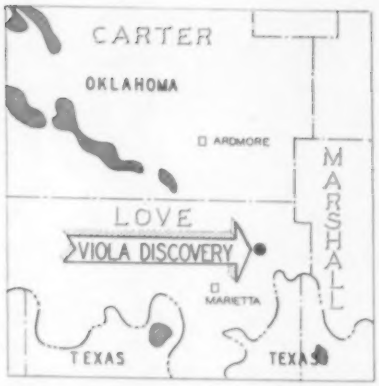

Arrow points to Frankfort Oil Co.'s Viola lime discovery in the Marietta area of Love County, extreme southern Oklahoma.

gas per day on a drill-stem test of the second Bromide sand at 11,503-581 ft.

The well evaluated the upper part of the Bromide at 11,382-11,478 ft. getting 2,820 M.c.f. of gas and a flow capacity of 48 bbl. of oil per hour. Recovery was 1,900 ft. of clean oil.

Completion Tests Taken At Marietta Viola Strike

The Viola lime discovery in Love County's Marietta area is being completed by Frankfort Oil Co.

It is the 1 Conrad, NW NW NW 34-6s-2e. The well found three sections of Viola lime showing 1,500 ft. of good zone. Production tests are evaluating the lowest part of the Viola section at 6,810-20 ft. The interval flowed more than 10 bbl. per hour after treatment.

Flow Tests Renewed at North Madill Field Well

Renewed flow tests are reported at the basal McLish well, Buffalo Oil Co. 1 Olmstead, NE SW NE 16-5s-5e. Initial flow of 3 bbl. per hour were reported from perforations at 6,012-44 ft. The North Madill field well has a current flow of 122 bbl. daily on ¼-in. choke.

Sinclair Oil & Gas Co., 1 Little, SE NW SE 15-5s-5e, flowed 995 bbl. of oil in 24 hours on ¾-in. choke and then tested 50 bbl. per hour for 3 hours on ¾-in. choke from perforations at 6,168-6,343 ft. Another well in the field, Samedan 1 Bounds, correlated 34 ft. higher than the field discovery well in the Simpson dense at 5,385 ft.

KANSAS

Mississippi Strike Is Promising Barber Producer

Barber County has a promising new Mississippian discovery at Purcell & Mull 1 Landis, SE SE SE 21-34s-11w.

A drill-stem test in the Mississippi at 4,618-30 ft. got 120 ft. of gas and oil-cut mud and 60 ft. muddy oil. A later test at 4,630-40 ft. got 60 ft. of slightly oil-cut mud and 120 ft. very heavy oil-cut mud.

This prospective discovery is located about 5 miles south of South Roundup field.

New Oil Producer Seen For Graham County Area

A new oil field is in the making for Graham County at Imperial Drilling Co. 1 Brown, SE SE NW 4-9s-23w. A drill-stem test in the Lansing lime at 3,762-86 ft. got 1,700 ft. of gas, 320 ft. of muddy oil, and 120 ft. clean oil.

This promising discovery well is located 3 miles south of Millbrook field.

Another strike . . . Brooks Hall and Benson-Montain 1 Huntington, SE SE SW 7-7s-25w, is a new prospect for Graham County.

A Lansing drill-stem test at 3,688-3,715 ft. recovered 1,320 ft. gas and 1,880 ft. of oil. Another test at 3,726-60 ft. got 200 ft. gas, 1,140 ft. oil, and 300 ft. salt water. The final and third test at 3,811-25 ft. recovered

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3,720 ft. of oil with a bottom-hole pressure of 1,285 psi.

This promising field-opener is ½ mile east of the Sheridan County line. It is 7 miles northwest of Schmied field production.

NORTH TEXAS

Oil Creek Discovery in Eastern Cooke County

New Oil Creek sand production has been opened in northeastern Cooke County, 10 miles northeast of Gainesville, and approximately 7 miles southwest of the big Sandusky area. The latter field opened Oil Creek production in Grayson County.

The new well is Ralph J. Abbey, Dallas, 1 W. G. Doezier, located in the J. W. Hamilton Survey. Completion potential on the pump was 171 bbl. of low-gravity oil a day, from perforations at 6,349-51 ft. Gas-oil ratio was 200:1. Top of the Oil Creek was picked at 6,345 ft.

A Pennsylvanian discovery in northwestern Grayson County is in the making. Russell Maguire 1 Brown, 4 miles north of Southmayd in D. Scott Survey, A-1171, recovered 4,735 ft. of free oil on a 2-hour test from 8,015-39 ft. Flowing pressure was 500-950 psi. and shut-in pressure reached 3,275 psi. Operators drilled ahead following the test. An earlier test, also in the Pennsylvanian, from 7,685-7,704 ft., recovered 2,574 ft. of free oil plus 98 ft. of salt water. Nearest production is the Big Mineral field, 3 miles north.

Grayson County gained a new flowing discovery 2 miles southeast of Sherman, at Lone Star Producing Co. 1 Mayhew. Potential was 263 bbl. of 40.8° oil a day through ¼-in. choke. Tubing pressure was 595 psi., gas-oil ratio was 1,860:1.

Production was through perforations in the upper zone at 10,885-90, 10,896-98, and 10,902-16 ft.

HUGOTON EMBAYMENT

SOUTHWEST KANSAS

Casing Set at Hugoton Field Morrow Discovery

Panhandle Eastern Pipeline Co. 2-20 Shuck, NE SW 20-33s-34w, 2½ miles north of Pleasant Valley in Seward County, has indicated first Morrow production for vast Hugoton field. Casing has been set.

Gas gaged 1,254 M.c.f. per day on drill-stem test at 5,986-6,009 ft. The discovery is between two pre-Permian discoveries of last year . . . Wide Awake-Toronto and Holt-Toronto fields.

Potential Taken at Clark County Confirmation Well

Potential gage is reported at Shamrock Oil & Gas Corp. 1 Stephens "B," N½ N½ SW 11-32s-21w, ½ mile northeast outpost and confirmation well to the recent Morrow discovery at Northeast Morrison field.

The confirmation discovery had a calculated open flow of 31,000 M.c.f. of gas per day plus 4 bbl. distillate per million from perforations in the Morrow-Pennsylvanian sand at 5,127-36 ft.

OKLAHOMA PANHANDLE

Cabot Well in Beaver Records Second Pay Zone

Cabot Carbon Co. has a second pay zone indicated at its 1-A Judy, NE SW 1-5n-24eCM, Beaver County discovery.

The wildcat tested 1,070 M.c.f. of gas per day on a drill-stem test in the Morrow sand at 6,189-6,226 ft. It had previously been assured Toronto gas at 4,698-4,724 ft. The wildcat, 2 miles northwest of Mocane field production, is the southwest offset to Cabot 1 Hodges, prolific Checkerboard oil discovery.

Pure Oil Co.'s link well in the area around Southeast Mocane and Northwest Knowles fields, the 2 Dixon, NE NE SW 29-5n-26eCM, flowed 6,500 M.c.f. of gas per day from Morrow sand at 6,828-36 ft. The well is 2 miles northeast of Mocane field production (Morrow and Mississippian.)

NORTHEAST NEW MEXICO

Sunray Moves in for Guadalupe Granite Test

Sunray Oil Corp. will drill a 5,000-ft. granite test 3 miles northeast of San Ignacio in the northwestern part of Guadalupe County.

The well is the A-1 New Mexico-Federal, 5-8n-19e. There is no production anywhere near the well. Location spots 4 miles east of a recent dry hole at 1 State.

WEST TEXAS-NEW MEXICO

WEST TEXAS

Discovery and Prospect For Gaines County

Gaines County was in line for two discoveries; one assured after making a heavy flow of oil, and the other a good prospect on the basis of drill-stem test recoveries.

The flowing well is Anderson-Prich-

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ard Oil Corp, United States Smelting, Refining & Mining Co., and Husky Oil Co. 1 Webb. Location is in Section 20, Block C-35, PSL Survey, west of the town of Seagraves. Top of the Devonian was 13,048 ft., and initial production was reported at 12,965-13,065 ft.

Mud and oil from that interval flowed in 91 minutes, which was turned into pits. Amount of flow was estimated at 60 bbl. an hour.

The prospector is Humble Oil & Refining Co. 1-B Riley, located 5 miles west of Seminole. Third test in the Devonian showed an increase in oil. This test was run from 11,560-90 ft. Recovery was 2,160 ft. of oil and 120 ft. of oil and gas-cut mud. Operators drilled ahead to 11,610 ft. for another test.

Previous oil shows were reported on tests at 11,505-40, and 11,535-55 ft. At 11,505-40 ft., recovery was 36 bbl. of oil. Flowing pressure ranged from 880-1,360 psi. Sample top on the Devonian was 11,502 ft.

Ector County: Humble Oil & Refining Co. 1-B York, 6 miles southeast of Penwell, reports additional Ellenburger pay section is indicated by drill-stem tests. A 5-hour test at 12,344-69 ft. reversed out 38 bbl. of oil and 17 bbl. of mud-cut oil. Gravity was 43.5°, flowing pressure 740-3,070 psi., and 30-minute shut-in pressure, 4,945 psi.

At 12,369-92 ft., operators lost circulation while attempting to reverse out. When circulation was restored, recovery from the test included 35 bbl. of oil.

The well flowed oil on test from 12,392-12,417 ft. Gas surfaced in 57 minutes, water blanket in 115 minutes and oil 15 minutes later, at the rate of 60 bbl. an hour. No formation water was reported on any of the tsets.

Devonian discoveries in two areas of Gaines County. Jones Ranch, Russell and Amrow are other Devonian fields.

SOUTHEAST NEW MEXICO

Drilling Pickup Noted As New Wildcats Staked

New wildcat projects and confirmation tests to recent discoveries were announced this week. These included a 11,700-ft. Devonian wildcat 4½ miles southwest of South Knowles-Devonian field. Sinclair Oil & Gas Co. will drill this well as 1 H. P. Saunders estate. Location in NW SW 3-18s-38e, is 5 miles northwest of Hobbs, in Lea County.

Charm Oil Co. 1 Cities Service, 13-17s-35e, Lea County, was drilling below 3,000 ft. on a 5,100-ft. contract. Location is 2 miles northeast of production in Vacuum field.

Signal Oil & Gas Corp. has staked location for an offset to its recent Permian limestone discovery, which found pay at 4,975-4,234 ft. The new test is 1 Danglade, a west offset, in 6-20s-38e.

Signal 1 Fred Turner, Jr., in 6-20s-38e, ⅜-mile southeast of the shallow discovery, will seek production to 9,300 ft.

Phillips Petroleum Co. will seek a shallower pay zone, one location east of Anderson-Prichard Oil Corp. 1 American Republics. The offset is 1 Cooper, and will be drilled to 6,800 ft. Anderson-Prichard's discovery completed as a shut-in gas discovery in the Devonian at 8,270-8,390 ft.

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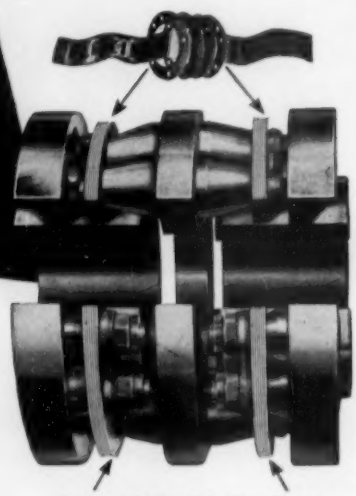

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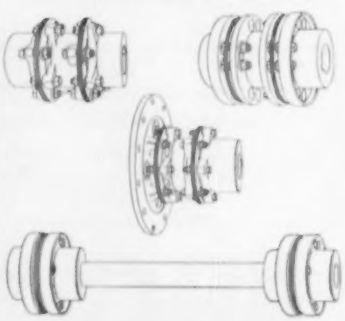

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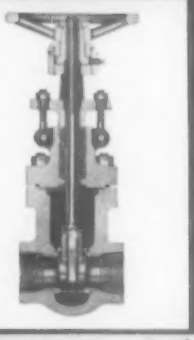

fig. no. 3651

o. s. & y., bolted bonnet gate valve. a premium valve available in a wide choice of trim materials and recommended where a full port opening is required.

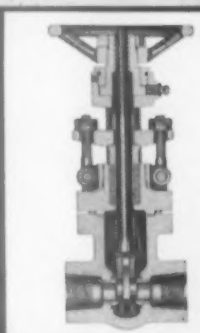

fig. no. 595

o. s. & y., bolted bonnet gate valve. comparable to fig. no. 3651 but somewhat more economical and its use is suggested where a full port opening is not essential.

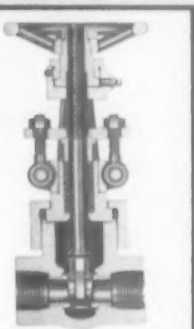

fig. no. 55

o. s. & y., union bonnet gate valve. an economical valve for those that prefer the compactness and dismantling features of the union bonnet construction.

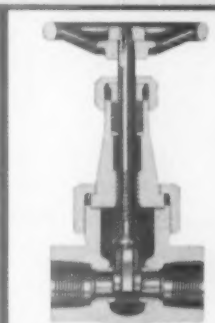

fig. no. 65

inside screw, union bonnet gate. a low cost compact valve for use where space and weight are important and where a full port opening is not required.

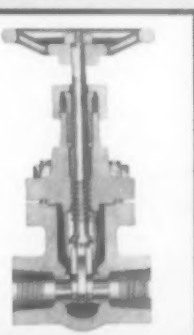

fig. no. 695

inside screw, bolted bonnet gate. the "competitor" to meet the tightest cost budget, yet offering the bolted-on bonnet feature. comparable to fig. no. 65.

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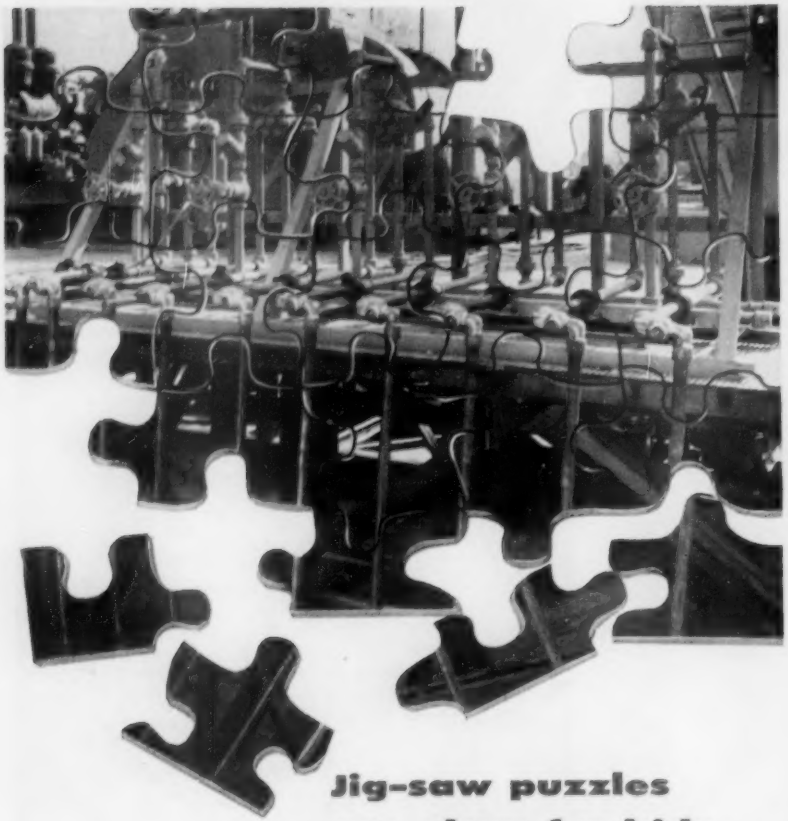

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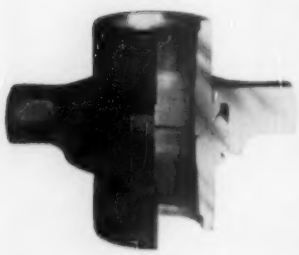

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GULF COAST

SOUTH LOUISIANA

Live Oak Extension Test Produces from Deep Pay

Houston Oil Co. is extending production of its Live Oak field, in southern Vermilion Parish, 1 mile to the southwest with its 1 Pierce, testing Miocene sand at 12,354-64 ft.

The well is reported to have flowed at the rate of more than 250 bbl. of oil per day through 7/32-in. choke in tests of perforations at 12,855-12,912 ft. Previous tests of intervals at 13,058-60 ft. and 13,004-06 ft. got flows of gas and condensate. Hole had been drilled to 13,130 ft.

The field's discovery well, 1 Godchaux, was completed in February 1954 with oil production from sand-interval at 12,334-40 ft. The second test, 1 mile to the east, was abandoned temporarily with stuck drill-pipe following a gas kick while drilling at 13,398 ft.

One other well, a dual-zone gas-condensate producer, ¾ mile south of the discovery well, has been completed. Completion, last November, was in sands at 12,490-95 ft. and 12,238-46 ft.

SOUTHWEST TEXAS

New Oil Production Opened In Webb County Discovery

Ralph Rowden, of San Antonio, appears to have a good oil-discovery well northeast of Volpe field, 10 miles northeast of Bruni, in eastern Webb County.

The discovery well, 1 Pedro Leal, in Survey 461, is reported flowing at the rate of 100 bbl. per day through ⅛-in. choke with pressure of more than 800 psi.

It is producing from perforations at 3,752-55 ft. Previously, in open hole,

Section of eastern Webb and western Duval counties showing Ralph Rowden's new oil-discovery well, 1 Leal, northeast of Volpe field. It is 10 mi'es northeast of Bruni.

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drill-stem tests got good oil recoveries higher in the pay, topped at 3,740 ft.

Location is only 2,100 ft. from the Duval County line. The same operator has another wildcat test under way about 1 mile to the north at 1 Perez.

Hidalgo County Wildcat Flows Gas-Condensate

A new gas-condensate area, located 4½ miles northeast of Sam Fordyce, in southwestern Hidalgo County, was uncovered by Houston Oil Co.

The discovery well, 1 Hotka, has been shut in without gaging, but, while cleaning, flowed gas and 62.5°-gravity condensate under pressure of 2,500 psi. Shut-in pressure is 2,825 psi.

Pay is perforated at 7,108-14 ft. Total depth is 8,384 ft.

New Chalk Oil Production Uncovered in Frio County

Sutton Drilling Co. has clicked with another Austin chalk oil-discovery in eastern Frio County. It is 2½ miles southeast of a chalk discovery well completed by the same company last November.

The new discovery is in the company's 1 Brazeale, in the BS&F Survey, 7 miles east of Pearsall. Testing the chalk pay in open hole at 5,551-5,702 ft., the well swabbed at the rate of 12 bbl. of oil per hour.

Sutton's first chalk discovery-well, 1 Newsom, in the Pedro Flores Morales Survey, flowed initially at the rate of 648 bbl. of 36°-gravity oil per day through 13/64-in. choke. Its pay is in open hole at 5,240-85 ft.

TEXAS GULF COAST

Frio Oil Producer Opens New San Patricio Field

A new oil-productive area is in the making 3½ miles west of Aransas Pass, in southeastern San Patricio County.

Discovery well is a joint operation of Conroe Drilling Co., Heep Oil Corp., and Renwar Oil Corp., of Corpus Christi, at 1 Ola McCann, in the W. Smith Survey.

It is completing in Frio sand, perforated at 7,794-97 ft., with bottom at 7,798 ft. In pre-potential tests, it flowed at the rate of 59.75 bbl. of pipeline oil per day through 7/64-in. choke, with pressure of 1,325 psi. Gas-oil ratio was 846 cu. ft. per barrel. Gravity of the crude is 42°.

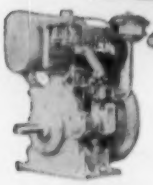
Location (arrow), in southeastern San Patricio County, of new oil-discovery well tested by Conroe Drilling Co. and others.

New Jefferson Discovery Produces Gas-Condensate

Cyprus Oil Co.'s new gas-condensate discovery well in western Jefferson County is rated good for 39,000,000 cu. ft. of gas per day on open-flow tests. Condensate recovery is at the rate of 1 barrel to 36,000 cu. ft. of gas.

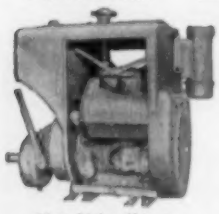
The discovery well, 1 Bauer, opens an entirely new field. Location, in the G. J. Peterson Survey, is 5 miles northwest of Fannett, and about the same

Vital Oil Circulating Pump powered by WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE



3 to 9 hp. single-cylinder models.

7 to 15 hp. 2-cylinder models.



15 to 36 hp. V-type 4-cylinder models.

Down at a field in Stephens County, Oklahoma, this oil circulating pump works, hour after hour, day after day. It's powered by a Wisconsin Heavy-Duty Air-Cooled Engine, best choice when you need an engine that's built to deliver continuous heavy-duty service.

And in the oil fields the story is the same wherever equipment reputation is built by reliability. Oil men know that Wisconsin Engines go on delivering dependability day after day, month after month. The reasons for this kind of service are many. Such features as tapered roller bearings at both ends of the crankshaft, and fool-proof air-cooling in all temperatures are very important performance factors. Also contributing to no-complaint operation is a trouble-free ignition system with an easily-serviced OUTSIDE magneto, along with heavy-duty construction even in those parts not vital to dependable service. No wonder, when you need power that *ranks first*, your *first choice* should automatically be Wisconsin Engines.

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This is one of the big reasons why oil men prefer to deal with independent distributors. They have enough problems on the rig during their daily tours, and enough headaches from meeting emergencies without having to worry about supplies. They know they can rely on their independent distributor to give them what they want, when and where they want it.

For example, take the 19 independent distributors (listed at right) who handle Pittsburgh Seamless Oil Country Goods. If you need a string of drill pipe, casing or tubing, you can count on them to have it on hand when you need it and often on short notice.

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distance northeast of Winnie (Chambers County). Nearest other production is in South Nome field, 2 miles to the northwest.

The new production is from the Frio-Nodasaria zone with perforations at 9,440-74 ft. Total depth is 9,646 ft. The well is shut in with pressure of 3,272 ft. Gravity of the recovered condensate is 55°.

Nueces County Wildcat Tests Oil-Showing Sand

Coastal Trend Oil & Gas Co. is testing oil showings in its 2 Schubert, a wildcat east of Southeast Clara Driscoll field, 4 miles southeast of Driscoll, in Neuces County.

Tests are in sand at 3,623½-27 ft., where 210 ft. of clean oil was recovered in a 20-minute drill-stem test through ¼-in. choke. Total depth is 3,755 ft.

Location is 2,100 ft. northeast of the operator's first test, a dry hole at 6,464 ft.

New-Pay Discovery Extends Production at Wadsworth

Production in the Wadsworth area, of Matagorda County, is being extended to the west with a new-pay discovery by Magnolia Petroleum Co. at its 1 Francis Savage.

The well, perforated at 9,928-38 ft., flowed through 5/32-in. and ⅞-in. chokes at the rate of 218.3 bbl. of 34.1°-gravity oil per day. Flowing pressure was 925 psi., and gas-oil ratio 822 cu. ft. per barrel.

Hole is plugged to 9,966 ft. from a total depth of 13,913 ft.

Magnolia is starting another deep well 1,550 ft. to the northeast, also on the west side of the field, at 2 Stewart Savage.

Sheldon Area Wildcat Completed as Producer

Houston Oil Co. is opening a new oil field 4½ miles northwest of Sheldon, in eastern Harris County, with completion of its 1 Swilley et al, producing from sand at 8,130-40 ft.

The discovery well, on potential gage, flowed 45.54 bbl. of 45°-gravity oil per day through 5/32-in. choke. Flowing pressure was 1,050 psi., and gas-oil ratio 11,304 cu. ft. per barrel.

Drilling is under way at a confirmation test, 2 Swilley, 1,927 ft. to the northwest.

The area is 3½ miles south of Alco-Mag field, nearest production, and 5 miles east of Dyersdale field.

ARK-LA-TEX

NORTH LOUISIANA

Operator Waits on Tanks At Tensas Oil Discovery

Tensas Parish has a new Tuscaloosa oil discovery awaiting completion at Jett Drilling Co.-Phillips Petroleum Co. 1 Plane-McDonald Unit, SW SW 46-11n-12e.

Arrow points to new Tuscaloosa oil discovery 3¼ miles southwest of St. Joseph, La.

The wildcat flowed 12 bbl. of oil per hour on 10/64-in. choke from perforations in the Tuscaloosa (Upper Cre-

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taceous) at 9,161-67 ft. opposite a 11½-ft. oil sand section. The oil is more than 40° gravity.

This new strike is located 2⅜ miles northeast of Locust Ridge field and 2½ miles northwest of Rodney Island field. The operators have already moved about ½ mile east to drill a 9,400-ft. offset test. The new well is the B-1 Alf Turner, 46-11n-12e. Northwest of this well on the same 40-acre tract Howard M. Jones has made location for another well in the new pool, the 1 Clarke-Jones, SW SE 46-11n-12e, Locust Ridge . . . H. L. Rowley is testing for completion at 1 Lowery et al, C SW SE SW 19-10n-11e, a new oil well in Locust Ridge field, Tensas Parish.

The well flowed 318 bbl. of 47°-gravity oil daily on ¼-in. choke from perforations at 9,102-09 ft. This is the second well in the field to produce oil. Another well is in prospect for the field at Southern Natural Gas Co. 2 Philip Watson, C NE NW 28-10n-11e, a proposed 9,200-ft. Tuscaloosa well. This well will be the east offset to the first oil well in the field and the south offset to the 1 Lowery et al.

EASTERN INTERIOR

ILLINOIS

Big Oil Wells in Eldorado Completed in February

Fifteen producing oil wells were completed in the Eldorado area in February. According to the February drilling report 5 of the 15 came in for 1,000 to 1,200 bbl. daily, 5 more for 420 to 1,000 bbl., and 4 of the remaining 5 were approximately 200-bbl. wells. Most of these wells, including all of the best ones, are producing from the Waltersburg sandstone. Nine pays have been found in the area, ranging in age from Palestine to McClosky. At the end of February, there were 108 producing wells completed in the pool. About a third of these were Aux Vases sandstone wells, and a quarter produce from the Waltersburg sandstone, most of the latter having been completed in the last 3 months. The area was producing an estimated 18,000 bbl. per day at the end of February, or an average of about 165 bbl. per well, as compared with 7 bbl. per well per day for the state as a whole. About 55,000,000 cu. ft. of gas was being flared daily as of March 2, 1955. The Warren Petroleum Corp. has discussed plans for the possible moving of its plant for extracting gasoline from gas from Salem to Eldorado.

Well completions for the state in February showed a normal seasonal de-

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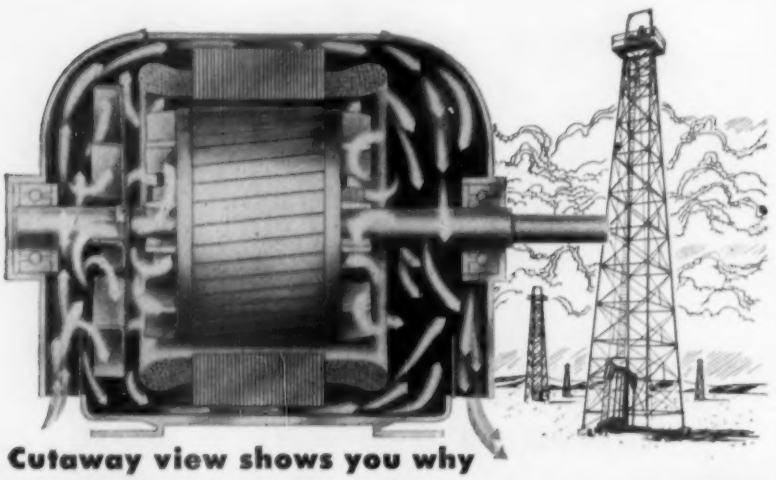
cline, the total for the month being 240, or 60 a week, but remained higher than a year ago when the weekly average was 44. The 240 completions included 128 oil wells and 1 gas well (in the Prentice pool). No new pool or extension was discovered; however, 2 new pays were opened up, the Aux Vases sandstone in Cooks Mills East in Coles County and the Devonian limestone in the Gays pool in Moultrie County.

Oil production is continuing to increase, the daily average for February being estimated at 208,000 bbl., as compared with 177,000 for February 1954. Estimated production for February 1955 was 5,813,000 bbl.

In Richland County, Sanders & Fye are testing the Cypress sand at 2,612-21 ft. at 1 Grubb, SW NE SE 18-3n-9e, west of Noble. The Cypress swabbed 20 bbl. of oil per hour natural for 6 hours.

In the Saline County Eldorado area J. D. Turner has a new pay for the area 1 mile northeast of the city at 1 Guy Westbrooks Community, SW SE NW 15-8s-7e. The O'Hara lime discovery prospect will be evaluated later.



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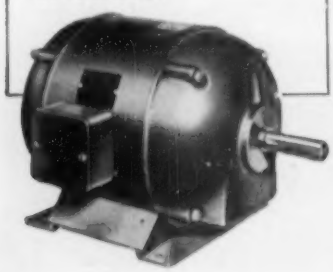

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Completion work has begun at the well in the Waltersburg sand at 2,129-55 ft.

WESTERN KENTUCKY

In the area 5 miles southeast of Utica Maxwell pool is rapidly developed. Wells in the new field have been completed for as much as 354 bbl. per day with production from the Palestine and Tar Springs.

GREAT LAKES

MICHIGAN

Deeper Drilling Due on North Flank of West Branch

A new Richfield oil well on the north flank of West Branch field, West Branch Township, Ogemaw County, may stimulate additional deeper pay drilling on this down dip side of the structure.

This new Richfield producer, as good as, or better than the best previous Richfield well in the area, was drilled by Walter L. Harvey at the 1 Babcock, SE NE SW 18-22n-2e. Harvey, a resident of Jacksonville, Fla., but an original native of Michigan, has here found success at his first oil venture. Well was rated good for 100 bbl. of oil per day, restricted flow, after acidization with 2,000 gallons. Pay zone was logged at 4,086-98 ft. Location was being cleared for the east 40-acre offset to this new well, while Harvey will start drilling operations at the west 40-acre offset within the next 30 to 45 days.

Northville area . . . With about 200 ft. of Trenton-Black River objective yet to be cored, Pure Oil Co. 1 Wayne County, NE SW SW 16-1s-8e, Northville Township, the most southeasterly well drilled to date in the area, has cored and tested gas pays which have gaged more than 1,280 M.c.f. of gas per day.

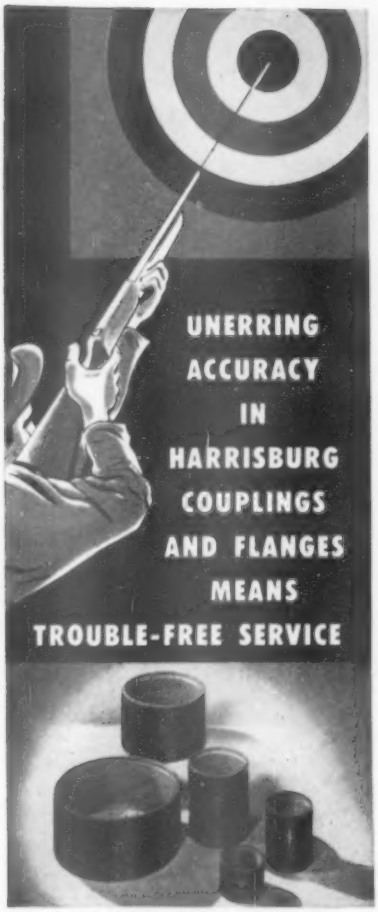
APPALACHIAN

WEST VIRGINIA

In Washington district, Upshur County, West Virginia, Washington Natural Gas Co. 1 Minnie Cress, wildcat, elevation 2,120 ft., was dry, show gas 1,678-94 ft., TD 1,961 ft.

Circleville district, Pendleton County, Columbian Carbon Co. 2-1203 U.S.A., elevation 3,911 ft., recorded the chert at 6,145 ft., and is running 7-in. casing at 6,158 ft.

Dry Fork district, Randolph County, Columbian Carbon 1-1207 L. F. Berger, elevation 2,543 ft., ran the tubing



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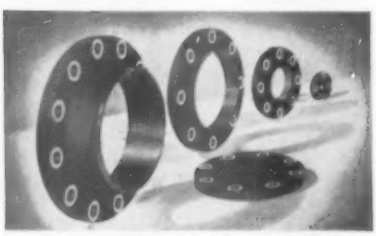

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to hydrofrac the chert recorded at 4,859-4,935 ft., Oriskany sand 4,985 ft.

OHIO

Several small pools are being developed in Knox County in addition to the larger ones in the southeast part. In Brown Township, Upham & Ridgeway 2 (1) Henry Festler, Section 22, made 125 bbl. after treating a fair showing of oil in the Clinton, found at 2,668-2,712 ft.

● In Union Township, Guy Horn 4 fee, Lot 9, reported a good showing of oil natural in Clinton at 2,857-2,905 ft., and 100 bbl. in a 24-hour test after fracturing.

● Preston Oil 4 Wyskiver, Section 34, Starr Township, Hocking County, made 25 bbl. natural in Clinton at 2,967-99 ft. and 280 bbl. in a 24-hour test 6 days after fracturing.

EASTERN KENTUCKY

In Big Sandy gas field, Columbian Fuel Corp. has deepened their 1 Charlie Murray located on John's Creek in Pike County. Well previously produced gas from the Mississippian Maxon sand at 1,634 ft. and deeper drilling to 3,193 ft. found gas in the Devonian black shales 3,140-45 ft. which, on initial open flow, gaged 678,000 cu. ft. daily. A 10-hour rock pressure test recorded 420 psi.

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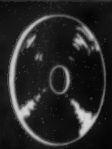


PACIFIC COAST

CALIFORNIA

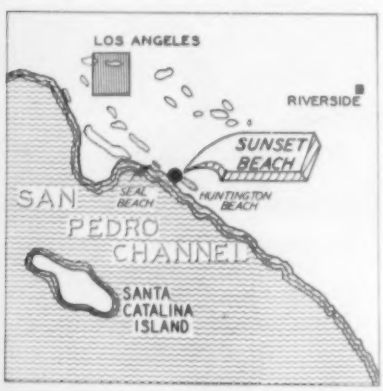
Long Beach Deep Test to Redrill

Oceanic Oil Co. was preparing to redrill its wildcat 2½ miles southeast of Long Beach Airport pool. Mechanical difficulties halted attempts to test showings found at about 8,350 to 9,973 ft., total depth. Hole was to be plugged back for redrilling the Brown zone to about 5,400 ft. The deep pay encountered by 1 Brown-Updike was not believed to be equivalent to that of the 9,000-ft. Airport pool.

Herley - Callahan Operations slant well drilled from a location 1 mile southeast of the pool was being placed on the pump. It likewise is thought to have failed to find the Airport zone as such in drilling to 11,005 ft.

Townlot Drilling in Line for Sunset Beach

The new Sunset Beach field, which may develop to fill the gap between Huntington Beach and Seal Beach production, appeared to be in line for close well spacing. Portions of the area have been subdivided into one-acre tracts. Eight 6,500-ft. wells underway



Close well spacing is indicated for new Sunset Beach field. This field may develop to fill the gap between Huntington Beach and Seal Beach production.

there and locations have been staked for others. Sunset Oil Co. has started 1 Carrol Community and plans two others on a 4-acre lease in SW SE 20-5e-11w.

About ½ mile south of this well Signal Oil & Gas Co. was having dif-

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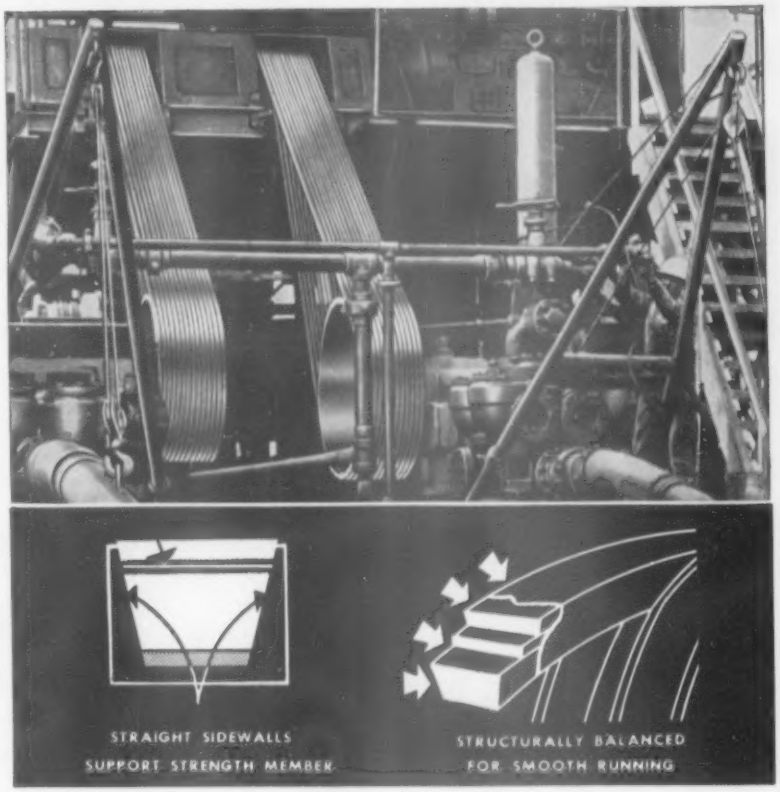
To assure full power delivery on the drive, all cords of the belt strength member should pull equally. If they "sag", as in some constructions, the outer cords are overworked, uniform power delivery is impaired . . . and premature belt failure results. Straight belt sidewalls help support strength members in a straight line to permit all cords to deliver their maximum share of power. In addition, when inelastic stretch is removed from the V-belts during manufacture, you have further protection against lagging belts on the drive . . . you are assured controlled length of every belt in the set, fewer matching problems and longer belt life.

Specify, by name, the V-belt precision-balanced and engineered to deliver full horsepower capacity and "More Use per Dollar" on heavy duty drive operations . . . specify standard Condor or R/M Super-Power V-Belts.



CONDOR V-BELTS AND R/M SUPER-POWER V-BELTS

Manhattan engineers were first to recognize the four equally important component parts of V-belt strength and balance in the design of Condor V-Belts. Precision manufacture and micro-positioning of the vital strength member prevent sag in the power line . . . make Condor V-Belts the smoothest running V-belts made for multiple drive applications. During manufacture, strength members are pre-stretched to remove inelastic stretch that might otherwise occur on the job. This prevents power waste and frequent shutdown for belt take-up. Condor V-Belts have special humidity protection which minimizes matching problems. For longer life on high powered rigs, there are also R/M Super-Power V-Belts that deliver up to 40% more horsepower. They are oil-proof, non-spark and heat resistant.

Let an R/M representative show you why Condor V-Belts and R/M Super-Power V-Belts last much longer . . . mean "More Use per Dollar" in your drilling operations.

MANHATTAN RUBBER DIVISION—PASSAIC, NEW JERSEY

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Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
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FIRST CHOICE for Secondary Recovery Water Flooding...

The lower the expense of producing source water from wells for water flooding operations, the greater the ultimate profit.

Reda Pumps for source water wells provide many ways for lowering these production costs.

Improved design and longer operating life *lower* the cost of labor per barrel, *lower* the cost of maintenance per barrel, *lower* the investment cost per barrel, *lower* the cost of fluid per barrel.

Also the ability of Reda pumps to produce greater volumes in limited casing sizes and from greater depths often reduces the number of source water wells required.

Reda engineers have long been associated with water flooding operations and are fully qualified to assist operators in discussing their source water requirements.

REDA
PUMP COMPANY
BARTLESVILLE, OKLA.

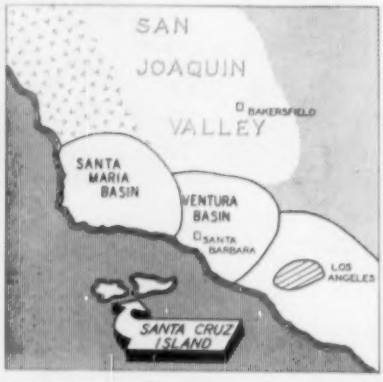
ficulty establishing commercial production in 161-A Signal-Bolsa. This deeper zone test was producing some fluid, including a high water cut, through perforations at 7,550-7,932 ft.

West Montalvo Extended

Standard Oil Co. of California extended production in Colonia pool of the West Montalvo field slightly over ¼ mile southeast upon completion of 1013 McGarth-5 for 1,080 bbl. daily. The Ventura County extensioner was drilled to 15,539 ft. but was plugged back to 13,138 ft. for completion in the lower Sespe pay.

New Midway-Sunset Pool

Exeter Oil Co. has discovered a shallower pay on its Murphy fee property in Midway-Sunset field, Kern County, where last year it opened a prolific new Miocene pool. The new zone opener was 14J Murphy fee in SW SW 28-32s-24e. It was completed flowing 214 bbl. of 28°-gravity crude from the interval 3,961-88 ft.



Richfield Oil Corp. was proceeding slowly with its test of the large block it has assembled on Santa Cruz Island, about 22 miles offshore from Santa Barbara. At latest report the wildcat was drilling below 6,800 ft. This is the first test of the 22-mile long island.

California Activity

Discovery of Gatchell sand (Eocene) production on the southern flank of Guijarral Hills, Fresno County, touched off a leasing spree which extended southeast several miles. Extent of the field, which is entirely separate from Guijarral Hills production, and may be of major importance, is yet to be determined. Three confirmation wells were under way.

Discovery of the Gatchell sand pinchout was Los Nietos Co. 55 Bourdieu. It flowed 30°-gravity crude at a 1,532-bbl. daily rate through 26/64-in. choke from 140 ft. of sand below 10,614 ft. Los Nietos, a Union Oil Co. subsidiary, and Standard Oil Co. of

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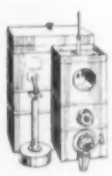

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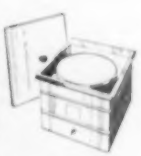

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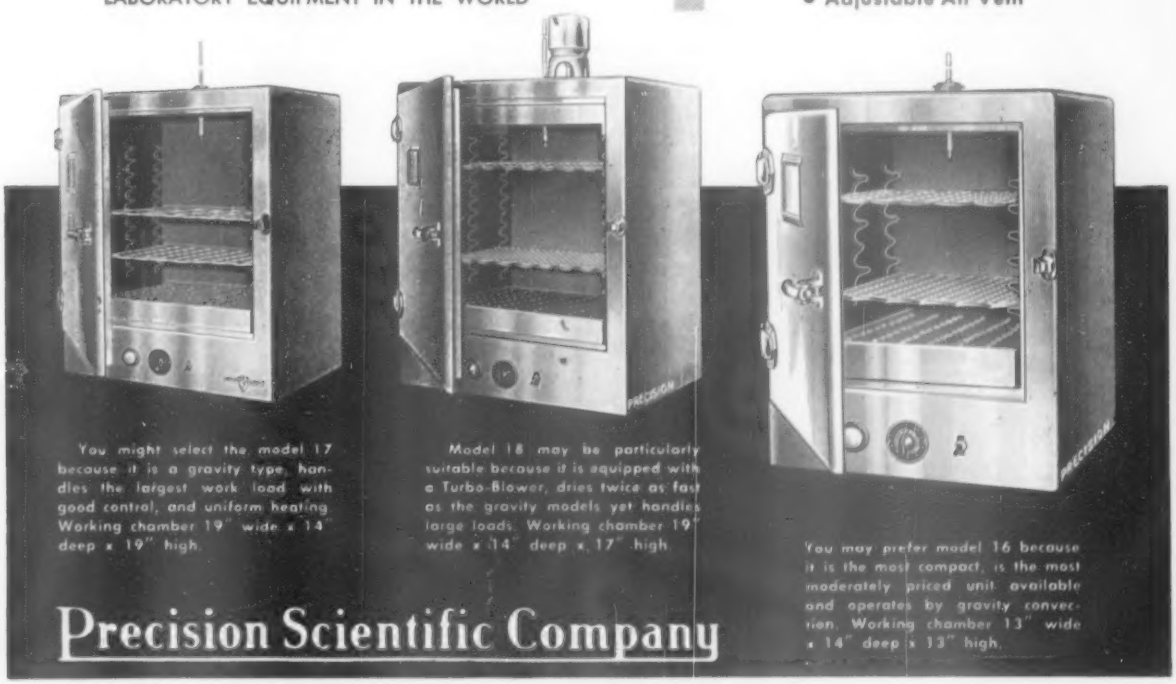

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California are major acreage holders around the new find, labeled the Polvadero field.

Exploratory drilling in California was tending to pick up slightly from the slow rate of the first 2 months. Only 65 wildcats were completed in the period this year as compared with 99 last year.

Reserve to Deepen Tejon Outpost to Jewett Zone

Reserve Oil & Gas Co. was preparing to deepen a northeast Tejon-Grapevine outpost, which failed in the Olcese, to about 7,000 ft. in order to test the Jewett zone. The well, in SW SW 23-11n-19w, was abandoned last November at 5,824 ft.

It is about 2½ miles northeast of the sole well completed in the Jewett. This is Drilling & Production Co. 33-33 J.V. in SE SW Section 33, at a depth of 7,000 ft. Reserve 12 Reserve-Pauley in NW NW 34 found the zone gas and condensate bearing in an up-structure position. This test currently is drilling for the Vedder zone at a depth below 11,100 ft.

Pipe Set in Huntington Beach Extension Test

Signal Oil & Gas Co. apparently has extended production in the 5,200-ft. Main pool at Huntington Beach to the 46-acre tract it recently was awarded by the city of Huntington Beach. Bottomed at 5,450 ft., 1 Huntington Beach City had 7-in. casing set at 5,250 ft.

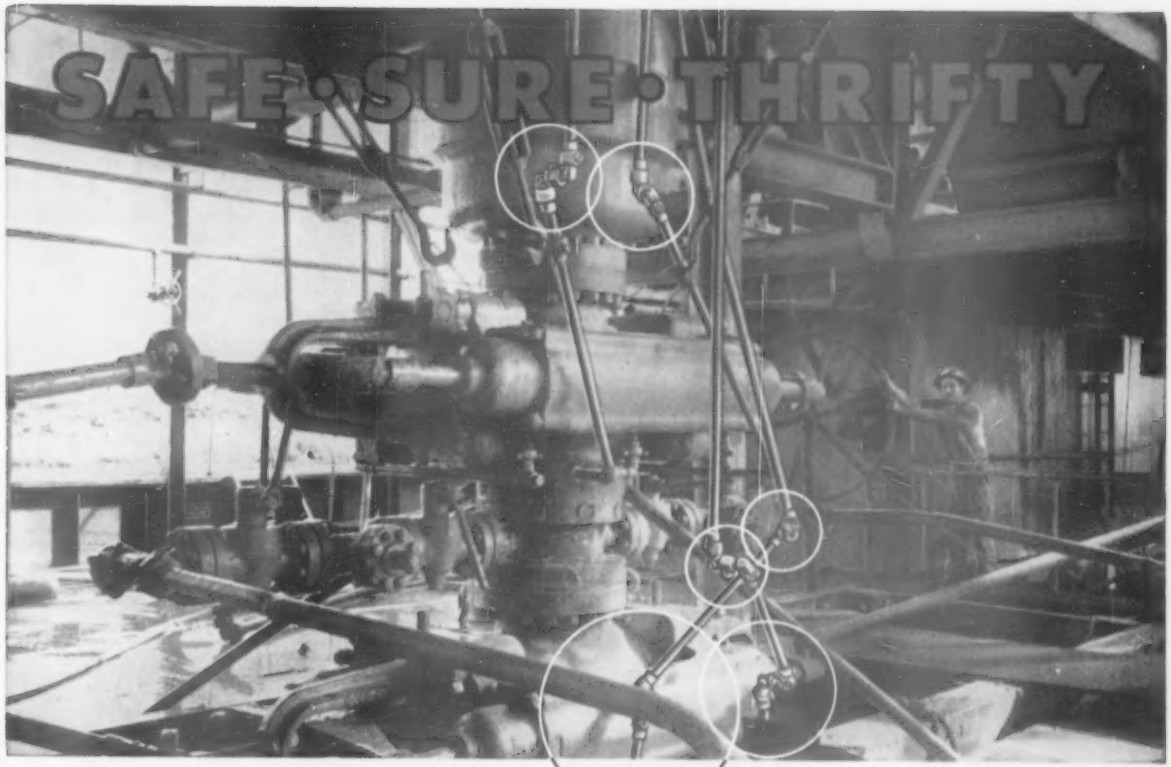
The well is located ¼-mile southeast of Standard Oil Co. of California 2 Atlanta Community, recently completed in the Main zone for 600 bbl. daily. Neither is thought to have found the 3,900-ft. Jones sand productive. Signal will pay the city a 37.5 per cent royalty on any production developed.

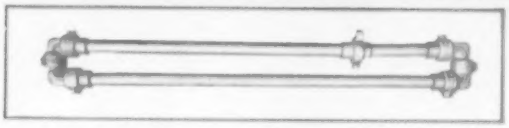
On the north edge of Huntington Beach field another Signal wildcat was attempting to establish deeper production on its Bolsa lease. Six intervals between 7,546 and 7,700 ft. were being tested. The well 161-A Bolsa, is about ½ mile south of Sunset Beach production of a similar depth.

Sunray to Drill Ten Wells at Beehive Bend

Sunray Oil Corp. plans to drill 10 development wells in the Beehive Bend, Sacramento Valley gas field, Glenn County, California, during 1955.

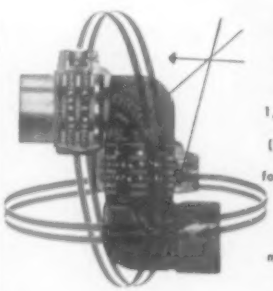
The multizone field was discovered by Sunray in 1953. The company has completed six gas wells which are shut in, pending completion of a gas pipeline being built. Sales of gas from the field





CHIKSAN High Pressure Cementing and Circulating Hose incorporates CHIKSAN forged steel swivel joints with flame-hardened ball races and high pressure type packing units. Maximum working pressure is 6,000 psi; for extra high pressure, CHIKSAN joints to 15,000 psi with maximum temperature 225° F.

CHIKSAN All-Steel Rotary Hose comes in two types — the Heavy Duty Rotary Hose for standard rigs and the All-Steel Rotary Hose for Portable Rigs. Both types of CHIKSAN Rotary Hose provide uniform strength and maximum safety.



CHIKSAN Ball Bearing Swivel Joints are The SAFE — SURE — THRIFTY Tool of the Petroleum Industry — with full 360° rotation in 1, 2, and 3 planes. Over 1,000 different types, styles and sizes from ⅜" to 12" (larger sizes on special order) have been developed for pressures and services from 28" vacuum to 15,000 psi and for temperature ranges from minus 75° F. to a plus 500° F. Packing materials have been designed for each specific service.

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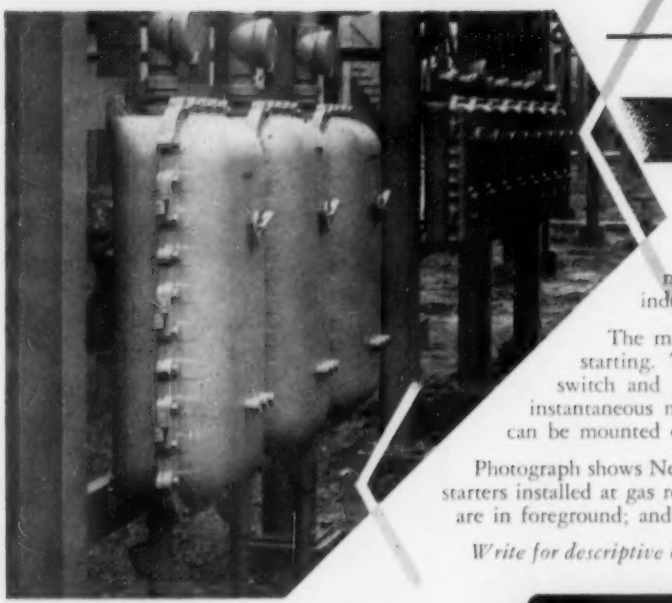

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Because they assure automatic protection and control at all times, literally thousands of our Class 420 explosion-proof combination motor starters are in use throughout the oil industry in all parts of the world.

The magnetic motor starter provides "across-the-line" starting. The air circuit breaker is used as a disconnect switch and provides short circuit protection by means of instantaneous magnetic trips. Where desired, control stations can be mounted on the covers of the starters.

Photograph shows Nelson Class 420 explosion-proof combination starters installed at gas re-cycling plant. Three size 4 starters are in foreground; and eight size 2 starters in background.

Write for descriptive bulletin 420.

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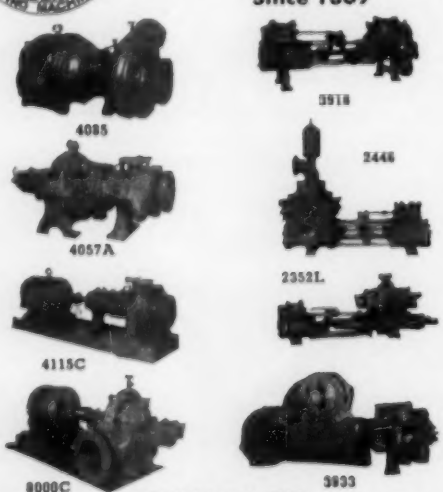

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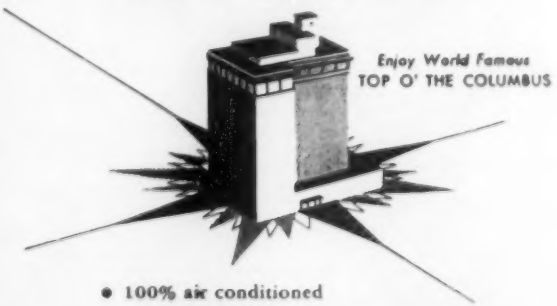

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are scheduled to begin in the fourth quarter of this year.

The proven area of this field in which Sunray holds several thousand acres, has recently been extended 2 miles northwest, where the company holds substantial offsetting acreage.

Three new wells will be drilled immediately, as the result of geological information which indicates substantial potential reserves. The wells include the 160-acre 1 Whyler-Michael Unit well; the 160-acre 1 Whyler-Walcott Unit well; and the 154-acre 1 Whyler-Moutrey Unit well, all located in the vicinity of the presently producing 2 Rheem-Zumwalt well, Glenn County.

ROCKY MOUNTAIN

WYOMING

Madison Test Staked on Southern Big Horn Basin Flank

Sinclair Oil & Gas Co. has made location for a 3,200-ft. test of Madison at 1 Pumpkin Draw, NW NW NW 14-8n-2e, in Hot Springs County. The well is 6 miles south of Madison production in Hamilton Dome field. There has been no previous drilling in the immediate area.

A southern Big Horn basin area of no previous drilling will see a 3,200-ft. wildcat put down. It is Sinclair Oil & Gas Co. 1 Pumpkin Draw.

New Tip Top Production From Nugget

General Petroleum Corp. has identified the producing formation at 26-S-12 Tip Top Unit, SE NW SW 12-28n-114w, Sublette County, as from Nugget. The well was completed for a flow of 130 bbl. of oil and 10 of water per day from open hole at 9,874-91 ft. Previous reports of shows in Frontier and lack of official information as to the producing horizon had indicated a discovery in Frontier. The present well is now regarded as an extension to the General Petroleum Nugget discovery drilled in this unit in 1951.

New Bearcat Unit Test Staked

Mobil Producing Co. will drill a second test on the Bearcat Unit, Park County. The new location is for

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MODEL 5MH22, 5KW, 115 volt AC. Manual starting, with housing.

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Heavy-duty 5 KW model provides reliable power for rig lights, floodlights, maintenance tools—also mobile service on portable rigs. Operates with gasoline or natural gas. Engine is 4-cylinder, water-cooled. Other sizes, 500 watts to 35 KW includes portable models for seismograph equipment, tape recordings, geophysical survey trucks. Diesel models available, 10 KW to 35 KW for lighting and galley equipment on quarter boats. Also stand-by models for refineries. Write for folder E-12.

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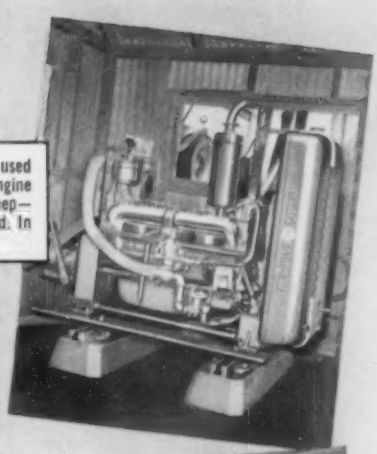
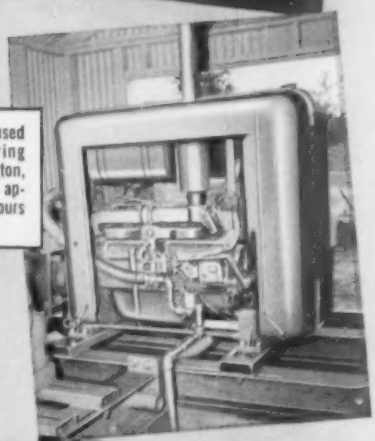


B-427 RED SEAL used as oil well pumping engine on well 6,000 feet deep—Falco, Texas oil field. In service 15 months.



M-330 RED SEAL used in oil field gathering system near Greggton, Texas. In operation approximately 9,000 hours without repairs.

F-140 RED SEAL used as oil well pumping unit in East Texas oil field. Fifteen years with only one ring job.

F-226 RED SEAL used as oil field pumping engine. In use approximately 4 years with no down time.

Continental Red Seal power is giving proof of its stamina in every type of oil field job within its broad power range. In production, in distribution, and in processing, you'll find Red Seals getting the call for more and more assignments. They're available for operation on all standard fuels. They deliver their full work quota at lower cost, with less down time. They keep on doing it, month after month, because every model is engineered expressly for its job—built to do one thing, and do it extra well.

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T-61-12-P, NE NW NE 12-56n-100w. It will test Tensleep at about 9,800 ft. It is 1 mile north of a recent failure drilled by this operator which went to Tensleep, with only slight shows of oil reported in that formation and in Phosphoria.

NORTH DAKOTA

Burke County Wildcat Location Reported

Carter Oil Co. has made location for a 7,500-ft. Mission Canyon test 19 miles northeast of production in Tioga field. The well is 1 Morrissey, C SE SE 6-161n-92w, Burke County. There has been no previous drilling in the area, which is about 6 miles southwest of the town of Lignite. Carter has done some drilling in the general Tioga area, but had done no previous wildcatting through Williams and Burke counties.

Stark County Tight Hole Said Coring Madison

Southern Production Co. and Texota Oil Co. are reported coring below 8,900 ft. at 1 Wanner, NW NW 9-137n-97w, Stark County. At this depth the well is believed in Mission Canyon, although no official data have been released by the operators. Four drill-stem tests, not officially publicized, have recovered no shows of significance according to unconfirmed reports.

MONTANA

Landslide Butte Test Resumed

Carter Oil Co. is again testing at 1 Thelen, C NE NE 13-37n-9w, in the Landslide Butte area of Glacier County. Operations had been suspended for several days due to impassable roads.

Arrow points to Carter Oil Co.'s 1 Thelen, Landslide Butte wildcat in Glacier County where testing has resumed.

At last report the operator was recovering 7½ bbl. of fluid per hour on swab, with 25 per cent oil content.

Apparent Discovery At East Bredette

The California Co. recovered 3,900 ft. of water, slightly gas cut, in drill-stem test of 1 Grimm, C NE SE 13-32n-49e, in the East Bredette area of Roosevelt County. The operator tested the zone 6,942-7,000 ft. Total depth is reported as 7,050 ft., with the operator last reported running another test.

The well was an apparent discovery in C zone of Charles, where a flow of 20 bbl. of oil per hour was tested.

COLORADO

Production Extended South In Plum Bush Creek Field

In Washington County Stanolind Oil & Gas Co. 1 State of Colorado "C," field well in Plum Bush Creek field, pumped 221 bbl. of oil in 24 hours from the upper Muddy and Muddy sands.

The upper Muddy was topped at 4,950 ft. and the Muddy at 5,008 ft.; plugged back total depth of the well

(Continued on page 375)

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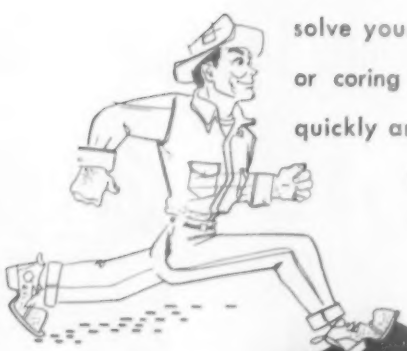

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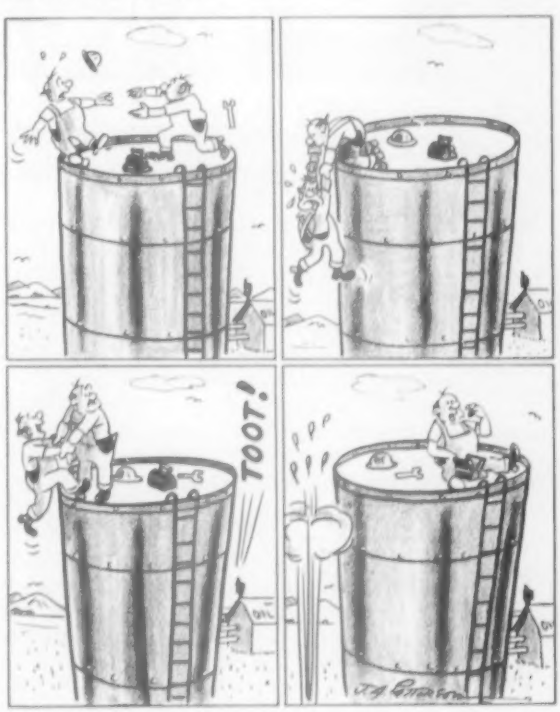

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If not—you may be jeopardizing the success of your flood!

Most operators agree that these standards for the flooding medium (water, produced brine, or both) are necessary for minimizing clogging of the input formation. Closed systems, or other types of partial treatment, seldom meet these exacting requirements. INFILCO *complete* treating plants, which include the highly efficient ACCELATOR® Stabilizer, provide water within the specified limits. Existing INFILCO installations are treating over 500,000 barrels per day with three-way economy: lower first cost, lowest maintenance and low, low chemical costs. INFILCO engineers have over 30 years experience in designing *complete* flooding water treatment plants. Be sure you are getting maximum oil recovery by consulting your nearby INFILCO engineer. If you prefer, write for complete information.

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PERSONALS

New Chemical Chief

Scott climaxes 21-year career with Sinclair

JOHN SCOTT, vice president of Sinclair Chemicals, Inc., has been promoted to president. The move climaxed a 21-year career which began as a research assistant with the parent Sinclair Oil Corp. when Scott was fresh out of college in 1934.

Scott has been executive vice president and a director of Sinclair Chemicals since the subsidiary was organized in 1952.

He played a big role in Sinclair's move into the petrochemical field. In 1951 he was named to head a committee studying the potentialities of petrochemical manufacture. Later that year when the Petrochemical Sales Division of the Sinclair Refining Co. was formed, Scott was named manager and supervisor of sales.

Banjo player . . . He moved into an executive spot when the separate chemicals company went into business the next year.

The 43-year-old Scott is a native of Two Harbors, Minn., where he won recognition as a proficient musician and banjo player. He helped pay his expenses through high school and University of Minnesota by playing in dance bands and working as a railroad yard clerk and telegraph operator.

He was graduated with distinction from university in 1934 with a bachelor's degree in chemical engineering. He immediately joined the Sinclair organization.

For 9 years Scott was a research and development engineer in East Chicago. He worked on process design and pilot-plant development of refining processes, specializing in alkylation and polymerization.

Pioneered process . . . Scott moved to Corpus Christi, Tex., in 1944 to supervise the design and start of Sinclair's alkylation unit, one of the first using the HF process. The next year he was called to New York to become assistant to the vice president in charge of research and development. He held that post until he undertook the chemical assignments for Sinclair.

Music still remains one of Scott's chief hobbies but over the years he also has added interests in swimming, golf, and wide reading. These he pursues while not preoccupied with Sinclair Chemicals or his other duties as vice president of Sinclair Rubber and board member of both the Sinclair Research Laboratories, Inc., and Calumet Nitrogen Products Co.

Mitchell A. Lekas, former geologist with Christensen & Matthews at Houston, has joined the Atomic Energy Commission at Grand Junction, Colo.

Robert E. Siverson has joined Tennessee Gas Transmission Co. at Midland, Tex., as area engineer. Siverson was with Sinclair Oil & Gas Co. at Hobbs, N. M., before joining T.G.T.

James P. Blayney, former maintenance and construction supervisor with International Petroleum (Colombia), Ltd., at Barrancabermeja, has joined North Star Oil, Ltd., as mechanical superintendent at its St. Boniface, Man., refinery.

James D. Hughes of Lane-Wells Co. has been elected chairman of the Nomads national board of regents for

J. D. HUGHES

J. H. FLANAGAN

1955. Hughes is vice president and general sales manager and a director of Lane-Wells. **John H. Flanagan,** Johnston Testers, Inc., has been named secretary-treasurer of the national board. Flanagan has been with Johnston Testers since 1942 in export work.

F. E. Turner, former geologist with Union Oil Co. of California at Olympia, Wash., has been transferred to Salt Lake City as division geologist.

H. Gerald Graham, geologist with Humble Oil & Refining Co. at Kerrville, Tex., has been transferred to Corpus Christi, Tex.

Wilbur L. Durr, geologist with Continental Oil Co., has been transferred from Casper, Wyo., to Farmington, N. M.

E. W. Endter has resigned as president of California Oil Co., eastern subsidiary of Standard Oil Co. of California. Endter is leaving the oil business to devote full time to other business ventures.

Paul L. Henderson, chief geologist for Ohio Oil Co., has been named to the board of directors and vice president of production. He succeeds **W. B. Emery,** who retires April 1 after 36 years with the company. Henderson joined Ohio in 1929 as a division geologist in Los Angeles. He transferred to Houston as division geologist in 1933. He was named chief geologist for the firm in 1944. Dr. Emery joined Ohio in 1919. He was named chief geologist in 1939 and in May 1944 was promoted to vice president and manager of production. He was elected to the board in 1945.

W. B. EMERY

P. L. HENDERSON

Dr. R. Dana Russell has been named supervisor of the geological section of Ohio Oil Co.'s research laboratory near Denver. Dr. Russell has been serving as senior consultant in geophysics and chairman of the scientific planning board at the Navy electronics laboratory at Point Loma, San Diego, Calif.

H. S. Dickson has been appointed vice president of Inland Oil & Uranium Corp., Denver. Dickson will be in charge of exploration and development. Dickson has been serving with Frontier Refining Co. for the past 3 years as general sales manager in the Rocky Mountain area. Before that he was

PERSONALS

sales manager for Derby Oil Co., Wichita, for 14 years and was with Skelly Oil Co. for 10 years.

Glen B. Gariepy has been promoted to chief geologist of Ohio Oil Co.

G. B. GARIEPY

R. M. WILSON

Gariepy joined the company in 1926 as a field geologist at Casper, Wyo. He was named district geologist at Bakersfield, Calif., in 1934 and in 1937 was named Los Angeles division geologist. He was named assistant manager of the company's Shreveport division in 1953. **R. M. Wilson,** division geologist at Shreveport, has been appointed to succeed Gariepy. Wilson joined Ohio in 1933 in geophysical work in Louisiana. He was named assistant division geologist at Shreveport in 1939 and advanced to division geologist in 1951.

David B. Brasfield, former geologist with International Petroleum Co. at Talara, Peru, has been transferred to Jackson, Miss., to serve with Carter Oil Co.

T. J. Fuson, Humble Oil & Refining Co., Houston, was elected chairman of the Southwest district of the Division of Production of the American Petroleum Institute at its recent annual spring meeting in New Orleans. Also elected were 12 vice chairmen of subdistricts. They are **A. D. Butler,** Oil Field Motor Service, Southwest Texas; **M. R. Hayes,** Phillips Petroleum Co., West Texas; **A. C. Dahl,** Shell Oil Co., Southwest Louisiana; **Ed Kuhn,** Bridwell Oil Co., North Texas; **W. W. Hammond,** Ralph E. Fair, Inc., Balcones area; **W. C. Best,** Gulf Refining Co., Arkansas-Louisiana-Texas; **Matt Gordy,** Stanolind Oil & Gas Co., South Louisiana; **J. G. Blevins, Jr.,** The Texas Co., Southeast New Mexico; **Russell Birdwell,** consulting engineer, Rio Grande Valley; **H. E. Treichler,** Houston Oil Co., Texas Gulf Coast; **Ira Laird,** Gulf Oil Corp., East Texas; and **Royal Reiss,** Aluminum Co. of America, South Central Texas. Elected co-secretary-treasurers were **Victor LeMay,** Mid-Continent Supply Co., and **J. M. Montgomery,** Halliburton Oil Well Cementing Co.

Charles Barry, chief engineer of Tuloma Builders, Inc., has been elected to the company's board of directors.

John H. Stotts has been appointed research chemist in the research and development department by Continental Oil Co.

G. H. Kuepker, former Texas Panhandle superintendent for Phillips Pipe Line Co., has been transferred to Odessa, Tex., as superintendent of the West Texas division.

Ronald J. Cernik, who recently changed his name from **Roman J. Crnkovich,** has joined Union Oil Co. of California as a production engineer at Whittier, Calif. Cernik had been serving as a technician with Sinclair Oil & Gas Co. at Marcus Hook, Pa.

M. W. Boyer, executive vice president of Esso Standard Oil Co., has been proposed to the stockholders for election to the board of directors of Standard Oil Co. (N. J.). His name will be submitted to the stockholders this month for the firm's annual meeting in May. Boyer joined the Jersey organization in 1927. He became head of Esso's Baton Rouge operations in 1945. In 1949, he was placed in charge of manufacturing operations for the company with offices in New York.

Earl M. Beebe, former plant superintendent for Peppers Refining Co. at Oklahoma City, has been transferred to refinery manager of Champlin Refining Co.'s Enid, Okla., refinery. Both firms are subsidiaries of Chicago Corp.

John R. Lewis, Seattle, Wash., businessman, and **Maj. Gen. R. B. Lord** (U.S.A., ret.), New York City, have been elected to the board of directors of Voss Oil Co. They replaced **George L. Culver** and **Edward S. Halsey,** both of Newcastle, Wyo., who resigned. Halsey will continue as secretary of the firm.

E. A. Wendlant, former acting chief geologist of Humble Oil & Refining Co., has been named chief geologist of the exploration department. **J. G. Patrick** has been appointed chief geophysicist of the geophysics exploration and research division. **J. Ben Carsey,** former chief geologist, has been named exploration advisor. **D. P. Carlton,** former chief geophysicist, has been named geophysics consultant.

Melvin F. Roberts, former division geologist with Sapphire American Petroleum, Inc., has been transferred by the firm to Newcastle, Wyo.

Seth L. Lobdell, geologist with Sun Oil Co., has been transferred from Eastland, Tex., to Gainesville, Tex.

A. W. Goodson, production foreman with Southern Production Co., Inc., has been transferred from Danciger to Midland, Tex.

Roy R. Die, former junior petroleum engineer with Humble Oil & Refining Co. at Corpus Christi, Tex., has been transferred to Encino, Tex., as district petroleum engineer.

Robert O. Faris, former production engineer with Atlantic Refining Co. at Odessa, Tex., has joined National Cooperative Refinery Association at Great Bend, Kans., as a petroleum engineer.

A. R. King, reservoir engineer with Atlantic Refining Co., has been transferred from Greggton, East Texas, to Odessa, West Texas.

Kenneth D. Raven has joined Tennessee Gas Transmission Co. at Houston, Tex., as a sales engineer. Before joining T.G.T. he was a development engineer with Texas Illinois Natural Gas Pipeline Co. at Chicago.

Ralph A. Koenig, division geologist of Ohio Oil Co.'s Tulsa division, has

R. A. KOENIG

T. K. BOWLES

been named division geologist at Shreveport, La., effective April 1. **T. K. Bowles,** assistant chief geologist in the firm's general offices at Findlay, Ohio, will become division geologist at Tulsa. Koenig joined Ohio in 1937 as district geologist and petroleum engineer at Hobbs, N. M. He has served as division geologist at Tulsa since 1945. Bowles began his permanent employment with Ohio in 1934. He was named assistant chief geologist at Findlay in 1949.

PERSONALS

F. L. JONES

Frank L. Jones has been promoted by Chicago Corp. from chief engineer to superintendent of plants, gas sales, and reserve engineering at the company's Fort Worth office. **L. E. McCloskey,** formerly petroleum engineer at Fort Worth, succeeds Jones as chief engineer. **W. L. Marler,** former gas superintendent at

L. E. McCLOSKEY

W. L. MARLER

Corpus Christi, is being transferred to Fort Worth as superintendent of gas sales and procurement.

Allen L. Lewis has been promoted to mechanical engineer in the maintenance department of the engineering division by Humble Oil & Refining Co. at its Baytown, Tex., refinery.

Cecil D. Robinson, former chief geologist with Taylor Oil & Gas Co. at McAllen, Tex., has been promoted to vice president in charge of exploration by Delhi-Taylor Oil Corp. at Dallas. Delhi Oil Co. and Taylor merged January 10, 1955.

George McLeod, former geologist with Trident Drilling Co., Ltd., has opened offices at Regina, Sask., for United States Smelting, Refining & Mining Co. The office will be a branch of the company's northern division, which headquarters at Billings, Mont.

D. M. E. McLarty, former division manager and area coordinator for Bay Petroleum Corp., has opened offices as a consulting geologist in Denver. McLarty has 12 years' experience in petroleum geology in addition to 12 years' experience as a mining geologist in Canada, Africa, and the United States.

J. B. Cook has been elected vice president of Woodley Petroleum Co. Cook, secretary-treasurer of the firm since 1944, will continue as treasurer in addition to being vice president in charge of finance. **E. David Philley** was elected secretary of the company. **J. W. Boothe** was elected assistant treasurer.

Gordon E. Jacober, former regional geologist and geophysical coordinator for Sun Oil Co. in Denver, has resigned to join North American Uranium & Oil Corp. as general manager at Denver.

George P. Walker, Jr., has joined the geological staff of J. M. Flaitz & R. B. Mitchell in the firm's Houston office. Walker, former district geologist with Continental Oil Co. in Lafayette, La., and Houston, will work mainly in the South Louisiana area.

Ed J. Hamner, former California area manager for Humble Oil & Refining Co., has been promoted to the newly created position of assistant manager of the exploration department in Houston. **John S. Bell,** assistant manager of the California area for Humble, has succeeded Hamner in Los Angeles. Hamner joined Humble in 1932 in the production department. He transferred to the exploration department in 1934, serving as a geologist in the Gulf Coast and southwestern Texas areas. He was named assistant chief geologist in 1946. In 1948, when Humble began its California operations, he was named manager of exploration. He became area manager in 1952.

Ralph E. Barker, former engineer with Continental Oil Co. at Westlake, La., has been transferred to Ponca City, Okla., as a designer-draftsman.

O. A. Boatright, plant superintendent with Warren Petroleum Corp. at Wichita Falls, Tex., has been transferred to Holliday, Tex., in a similar position.

B. W. Pickard has been elected president of California Oil Co., eastern subsidiary of Standard Oil Co. of California. Pickard, formerly assistant general sales manager of the parent company, succeeds **E. W. Endter,** who has joined the Louis E. Wolfson group attempting to gain control of Montgomery Ward & Co.

Dr. Frank G. Ciapetta of Socony-Vacuum Oil Co., Inc., has been named given Dr. Ciapetta during the society's receive its annual Precision Scientific Company Award. The prize, consisting of $1,000 and a certificate, will be given Dr. Ciapetta during the Society's 127th national meeting April 2 at Cincinnati. He won the award for his research on chemical catalysts.

DEATHS

W. F. Gutzler, 86, veteran oil man, died recently in a Tulsa hospital. Gutzler was born at Warren, Pa., and was with Central Refining Co., Lawrenceville, Ill., 14 years in the early part of his career. He later served 15 years with Panhandle Refining Co., Wichita Falls, Tex. He moved to Dallas in 1925 and was employed by B. J. Shaw and Union Oil Co. until he retired in 1950.

C. D. Bryant, 51, drilling superintendent for Allen & Morris Drilling Contractors, died recently at Corpus Christi, Tex. Bryant had lived in Corpus Christi since 1937.

Claud Hogue, 66, retired Sinclair Oil & Gas Co. employe, died recently in Tulsa. Hogue went to Venezuela for Sinclair in 1941 and supervised construction work for the company for 6 months. He retired in 1946.

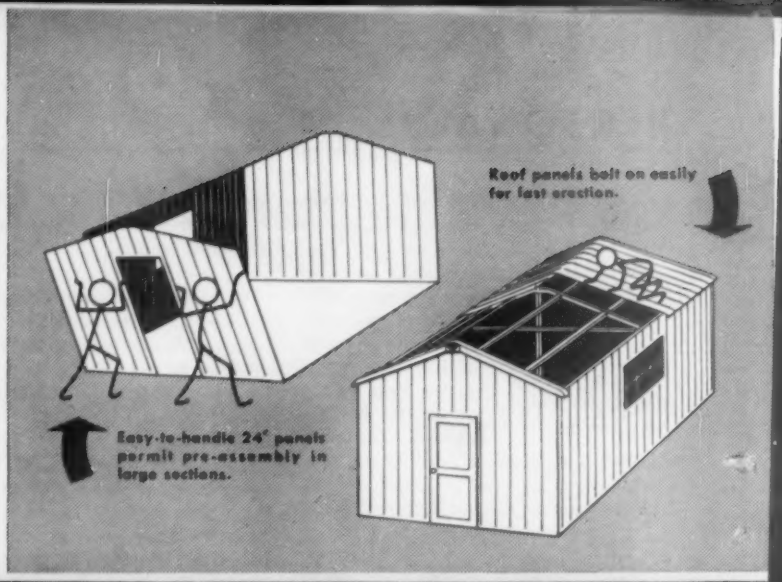
B. F. Green, Sr., 61, former Tulsa oil man, died recently in a Sarasota, Fla., hospital. Green was an independent operator in the 1940's until ill health forced his retirement about 6 years ago.

Charles F. de Mey, 58, vice president and chief engineer of Columbia Gas System Service Corp., died recently at his home in Stanford, Conn. He joined Columbia in 1929 and in 1945 was elected vice president and director of Service Corp. In 1951, he was named to the post he held at the time of his death.

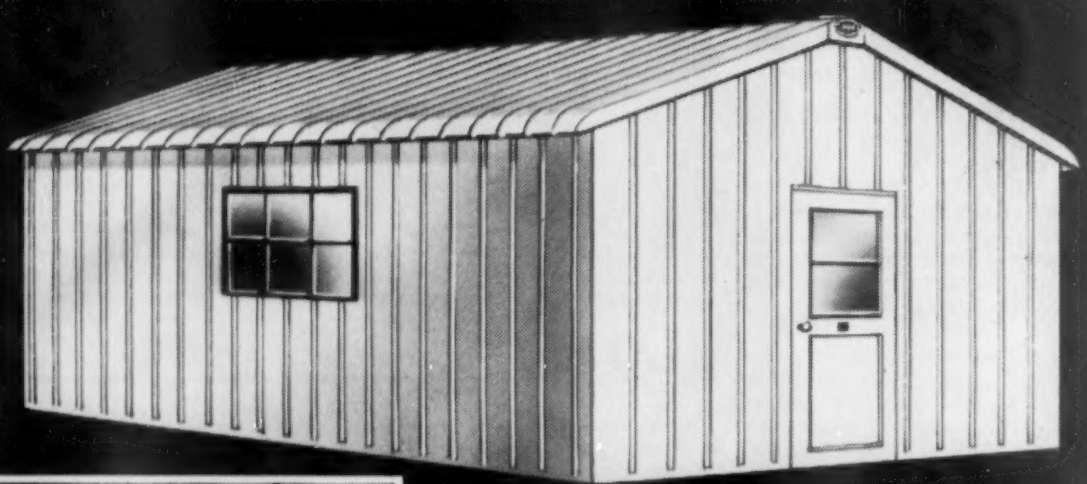
John W. Jackson, 55, senior labor relations associate with Magnolia Petroleum Co. and an employe of the company for 36 years, died in Dallas, March 12. Jackson started work for Magnolia in 1919 as a roustabout in the Oklahoma oil fields.

William Hardendorf, 60, independent Wyoming operator, was killed March 11, when a piece of oil rig, torn loose by high winds, struck him in the head at the Black Mountain oil field. He was in the oil business with his brother, A. J. Hardendorf.

NOW 2 men put it up with a wrench ...in hours



NEW BUTLER Panl-Frame Building



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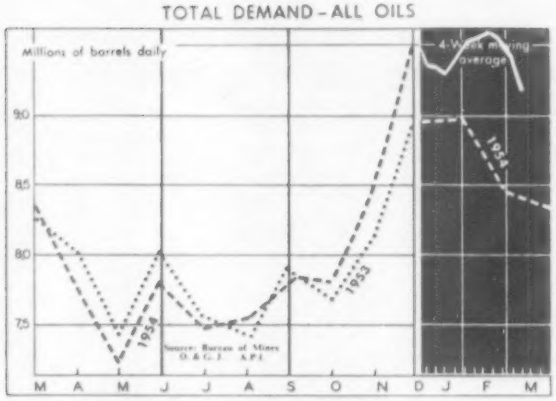
Latest Figures . . . Industry Trends

A QUICK LOOK AT THE HIGHLIGHTS

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	6,830,500	UP	329,690	UP	25,725
Crude stocks	261,281,000	DOWN	653,000	UP	1,351,000
Completions	919	DOWN	110	DOWN	94
Refinery runs	7,476,000	UP	596,000	UP	14,000
Gasoline stocks	183,424,000	UP	5,641,000	UP	1,081,000
Distillate stocks	63,832,000	DOWN	1,063,000	DOWN	2,100,000
Four-product stocks	310,796,000	UP	3,520,000	DOWN	650,000
Total imports	1,226,500	UP	303,500	DOWN	151,100

TOTAL DEMAND - ALL OILS



Domestic Demand for L.P.G. Gained 4.3 Per Cent in 1954

STARTING with 1954, the Bureau of Mines has been using a new method to determine the amount of L.P.G. shipped from natural-gasoline and cycling plants to refiners for blending into gasoline.

Prior to 1954, the total used was the sum of all shipments to refineries reported by plant operators. On the other hand, refiners reported larger receipts of L.P.G. than plant operators said they shipped. The bureau started using the refiners' total in 1954.

Since the new method shows larger shipments to refiners, less is left for fuel and chemical uses.

The bureau's December Monthly Petroleum Statement indicated a 1954 decrease in L.P.G. demand of 1.7 per cent. This was due to the fact that the years were not on the same basis.

It was not possible for the bureau to show 1954 on the 1953 basis, but it has converted final figures for 1953 to the 1954. While it is still possible that the 1954 method credits too much to refinery blending, the following tables show comparisons for 1954 and 1953 on the 1954 basis.

REVISED PLANT PRODUCTION AND DISTRIBUTION OF L.P.G. IN 1953 TO COMPARE WITH 1954

(Thousands of barrels)

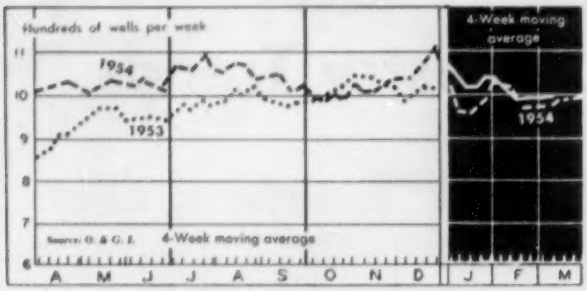
	Opening stocks	Production	Closing stocks	Deliveries from plants	Receipts at refineries	Fuel, chemical, etc.
January	2,144	9,660	1,627	10,177	2,463	7,714
February	1,627	8,588	1,569	8,646	2,258	6,388
March	1,569	9,273	2,034	8,808	2,483	6,325
April	2,034	8,989	2,075	8,948	2,353	6,595
May	2,075	8,826	2,714	8,187	1,931	6,256
June	2,714	8,302	3,072	7,944	1,948	5,996
July	3,072	8,829	3,495	8,406	1,947	6,459
August	3,495	9,070	3,956	8,609	1,988	6,621
September	3,956	9,045	4,328	8,673	2,182	6,491
October	4,328	9,556	5,084	8,800	2,321	6,479
November	5,084	9,545	4,891	9,738	2,347	7,391
December	4,891	10,326	3,688	11,529	2,528	9,001
Year	2,144	110,009	3,688	108,465	26,749	81,716
Dly. avg.		301.4		297.2	73.3	223.9

L.P.G. SUPPLY AND DEMAND—1954 BASIS

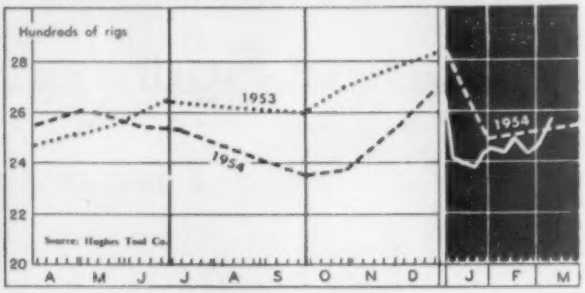
(Thousands of barrels)

	1954	1953	Change
L.R.G. from refineries:			
Stocks January 1	792	638	
Production for year	34,169	33,306	863
Stocks December 31	941	792	
Indicated demand	34,020	33,152	868
L.P.G. from plants:			
Stocks January 1	3,688	2,144	
Production for year	118,956	110,009	8,947
Stocks December 31	6,818	3,688	
Indicated demand	115,826	108,465	7,361
Blended at refineries	29,276	26,749	2,527
Fuel, chemical, etc.	86,550	81,716	4,834
Total demand (L.P.G. and L.R.G.):			
Fuel, chemical, etc.	120,570	114,868	5,702
Blended at refineries	29,276	26,749	2,527
Exports	3,939	3,002	937
Domestic demand:			
Fuel, chemical, etc.	116,631	111,866	4,765
Daily average	319.5	306.5	13.0

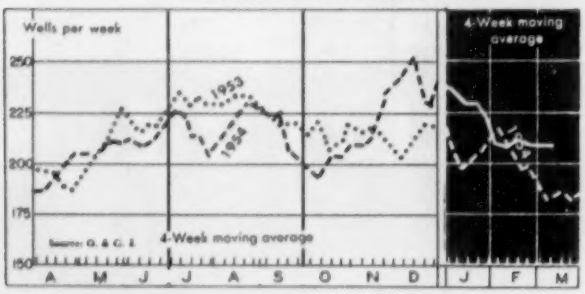
TOTAL COMPLETIONS



ROTARY RIGS OPERATING IN UNITED STATES



WILDCAT COMPLETIONS



ACTIVE ROTARY RIGS*

Area—	3-14-55	Change from 3-7-55	Change from 3-15-54
Gulf Coast	575	23	72
N. and W. Texas-New Mexico	857	12	45
Arkansas-N. Louisiana-E. Texas	174	8	—19
Oklahoma	326	19	—82
Kansas-S. Nebraska	181	2	20
Illinois-Eastern	124	28	— 7
Rocky Mountain	192	— 1	—43
Pacific Coast	145	— 2	—10
Total United States	2,574	89	—24
Western Canada	208	8	53

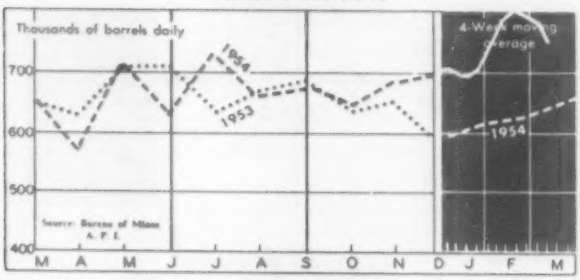
*Hughes Tool Co.

WEEKLY WELL COMPLETIONS . . .WEEK ENDED MARCH 12, 1955

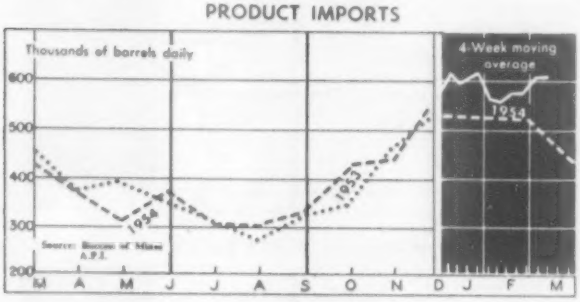
	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1955				
	Comp.	Oil	Gas	Dry	Footage	1955	1954	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
Ala.-Ga.-Fla.	1	0	0	1	6,245	24	24	0	0	0	1	1	0	0	0	23	23
Arkansas	10	4	0	6	47,523	97	123	0	0	0	5	5	7	0	0	28	35
California	47	33	0	14	226,641	450	478	2	0	0	9	11	7	0	1	71	79
Colorado	20	8	0	12	109,909	239	214	0	0	0	11	11	9	0	5	116	130
Illinois	44	28	0	16	104,352	717	492	1	0	0	7	8	12	0	0	89	101
Indiana	6	2	0	4	8,314	125	156	0	0	0	3	3	3	0	0	48	51
Kansas	76	36	6	34	280,237	951	800	3	0	1	15	19	29	0	7	151	187
Kentucky	21	9	3	9	34,465	249	215	0	0	0	3	3	9	0	2	44	55
Louisiana	53	39	3	11	372,849	718	596	3	2	1	6	12	25	12	6	69	112
North	23	16	2	5	60,889	381	297	0	0	0	2	2	3	2	1	30	36
South	30	23	1	6	311,960	337	299	3	2	1	4	10	22	10	5	39	76
Michigan	3	3	0	0	8,761	114	121	0	0	0	0	0	2	0	0	44	46
Mississippi	7	0	0	7	44,613	85	64	0	0	0	4	4	1	0	0	33	34
Montana	3	0	0	3	17,005	69	51	0	0	0	3	3	1	0	0	22	23
Nebraska	9	5	0	4	49,617	104	72	1	0	0	4	5	7	0	0	51	58
New Mexico	23	17	4	2	120,361	214	264	1	0	0	1	2	8	1	0	15	24
Northwest	6	0	4	2	29,588	54	78	0	0	0	1	1	1	0	0	4	5
Southeast	17	17	0	0	90,773	160	186	1	0	0	0	1	7	1	0	11	19
North Dakota	4	3	0	1	33,434	34	41	0	0	0	0	0	0	0	0	5	5
Ohio	22	10	2	*10	44,366	202	208	0	0	0	0	0	0	0	2	5	7
Oklahoma	145	92	8	†45	494,248	1,469	1,763	5	1	1	11	18	25	5	5	114	149
Pennsylvania-New York	23	7	5	‡11	58,160	332	464	0	0	0	0	0	0	0	4	3	7
Texas	380	234	14	132	1,546,662	3,559	3,390	11	1	2	80	94	135	14	23	754	926
Southwest (1 & 4)	65	32	3	30	275,490	571	491	0	1	1	22	24	19	6	8	144	177
Gulf Coast (2 & 3)	38	17	3	18	254,608	479	524	2	0	0	13	15	15	8	11	129	163
East (5 & 6)	13	2	0	11	71,548	203	142	0	0	0	9	9	7	0	0	59	66
North Central (7-B & 9)	169	108	3	58	476,156	1,213	1,259	8	0	0	30	38	70	0	0	292	362
West (7-C & 8)	79	64	2	13	410,742	897	808	1	0	0	5	6	24	0	2	126	152
Panhandle (10)	16	11	3	2	58,118	196	166	0	0	1	1	2	0	0	2	4	6
Utah	0	0	0	0	0	11	15	0	0	0	0	0	2	0	2	4	8
West Virginia	11	1	6	4	27,003	124	102	0	0	0	1	1	0	0	2	6	8
Wyoming	11	2	2	7	47,342	171	301	0	0	1	4	5	3	0	2	33	38
Miscellaneous	0	0	0	0	0	7	50	0	0	0	0	0	0	0	0	7	7
Total United States	**919**	533	53	333	3,682,107	10,065	10,004	27	4	6	168	**205**	285	32	61	1,735	2,113
Total previous week	1,013	600	65	348	3,929,435			24	1	7	153	185	258	28	55	1,567	1,908
Total March 13, 1954	1,029	593	73	363	4,070,470			34	2	6	149	191	273	32	66	1,698	2,069

Service wells included: *2, †9, ‡8.

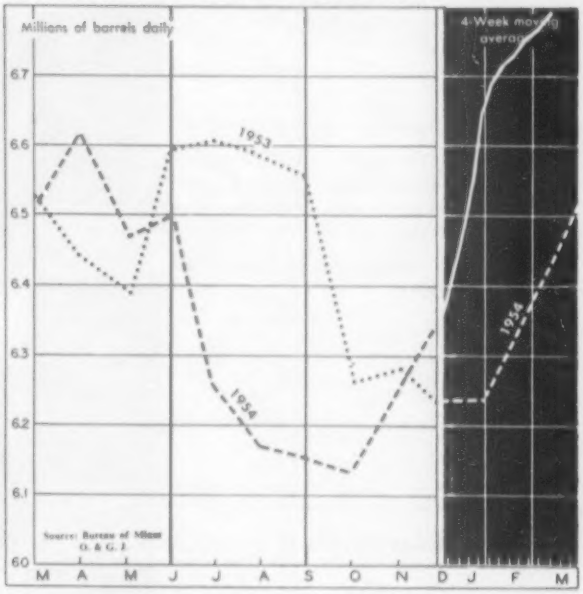
CRUDE IMPORTS



PRODUCT IMPORTS



CRUDE-OIL PRODUCTION



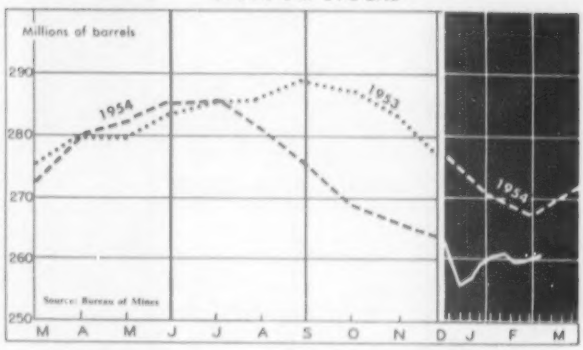
DAILY AVERAGE PRODUCTION FOR WEEK

	March 12 — Crude oil	March 12 — Lease condensate	March 12 — Total	Mar. 5 total
Alabama	4,100		4,100	4,200
Arkansas	72,600	400	73,000	74,250
California	970,300		970,300	969,000
Colorado	138,700		138,700	142,100
Eastern	48,500		48,500	48,500
Florida	1,400		1,400	1,400
Illinois	211,300		211,300	212,600
Indiana	27,500		27,500	29,300
Kansas	339,100		339,100	331,600
Kentucky	39,300		39,300	39,600
Louisiana	658,050	53,150	711,200	708,125
North	107,550	3,150	110,700	110,400
South	550,500	50,000	600,500	597,725
Michigan	31,800		31,800	32,100
Mississippi	90,750	5,000	95,750	95,800
Montana	42,500		42,500	41,900
Nebraska	28,500		28,500	27,400
New Mexico	223,950	4,450	228,400	226,275
North Dakota	28,900		28,900	29,400
Oklahoma	564,400		564,400	563,800
Texas	2,920,000	52,950	2,972,950	2,956,025
Dist. 1	51,000	600	51,600	50,950
Dist. 2	151,000	8,200	159,200	158,350
Dist. 3	455,000	24,675	479,675	477,525
Dist. 4	258,000	5,900	263,900	261,325
Dist. 5	49,000	525	49,525	48,900
Dist. 6	127,000	5,675	132,675	131,175
East Texas field	237,500		237,500	236,850
Dist. 7-B	143,000	50	143,050	141,775
Dist. 7-C	190,000	4,600	194,600	191,600
Dist. 8	976,000	2,025	978,025	975,450
Dist. 9	195,000	650	195,650	195,225
Dist. 10	87,500	50	87,550	86,900
Utah	4,200		4,200	4,700
Wyoming	268,400		268,400	266,300
Others	‡300		‡300	400
Total U. S.	6,714,550	115,950	**6,830,500**	6,804,775
Change from previous week, up			**25,725**	
Canada	†304,325		†304,325	†269,400

Total U. S. production January 1-March 12 ..... 477,112,775 bbl.
Same period last year (crude plus cond.) ..... *450,082,770 bbl.

*Includes 7,316,675 bbl. condensate. †Week ended previous Monday. ‡Incl. S. D. 100, Nev. 200.

CRUDE-OIL STOCKS



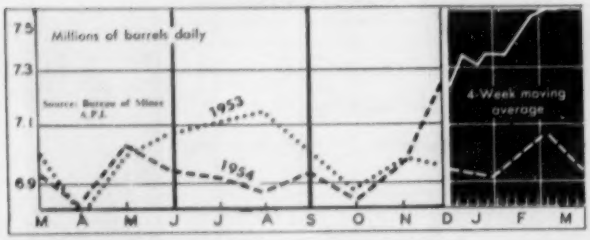
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

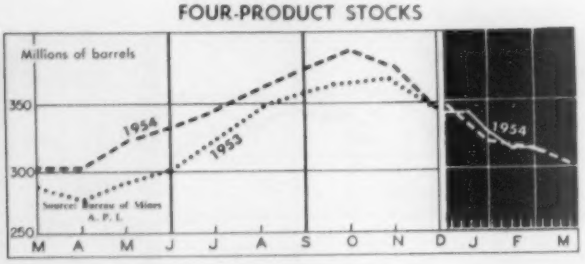
	Mar. 5, '55	Feb. 26, '55	Mar. 6, '54
Pennsylvania Grade	2,804	2,821	2,709
Other Appalachian	1,996	1,903	1,648
Illinois, Indiana, Michigan	11,375	11,471	11,695
Nebraska, N. Dakota	1,815	1,869	(‡)
Kansas	8,334	8,387	9,804
Oklahoma	24,073	23,530	25,885
Arkansas	2,943	3,003	3,124
Louisiana	14,140	14,604	14,427
North	2,558	2,336	2,646
South	11,582	12,268	11,781
Mississippi	3,102	3,137	3,329
New Mexico	8,465	8,546	7,539
Texas	118,951	117,727	119,626
East Texas proper	10,527	10,330	10,782
West Texas	52,120	51,649	50,844
Texas Gulf	23,572	23,920	25,049
Other Texas	32,732	31,828	32,951
Wyoming	13,751	13,996	13,168
Other Rocky Mountain	5,338	5,378	3,422
California	32,353	32,004	34,061
Foreign	†11,841	11,554	11,497
Total	261,281	259,930	261,934

*Bureau of Mines. †Includes 3,479,000 bbl. in California. ‡Included with Kansas.

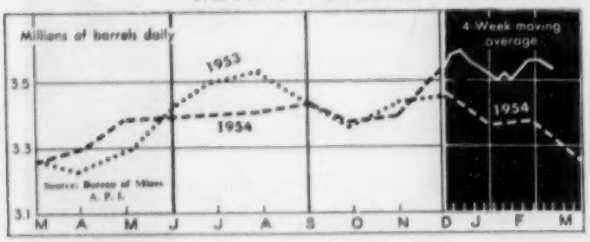
REFINERY RUNS



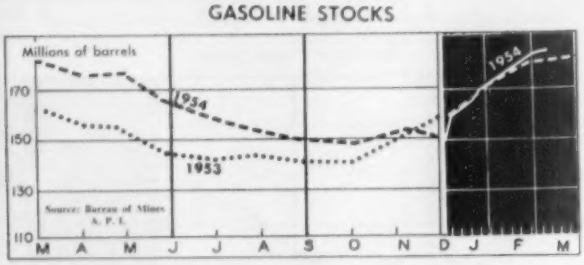
FOUR-PRODUCT STOCKS



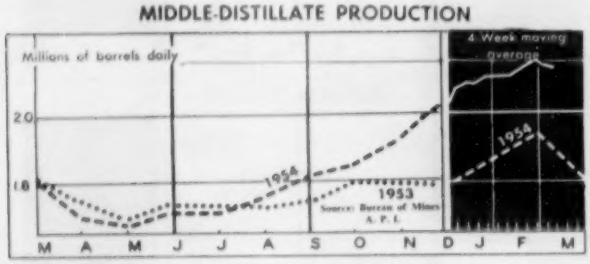
GASOLINE PRODUCTION



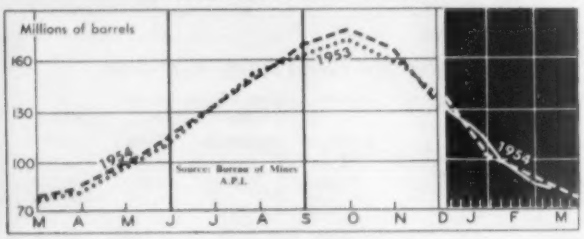
GASOLINE STOCKS



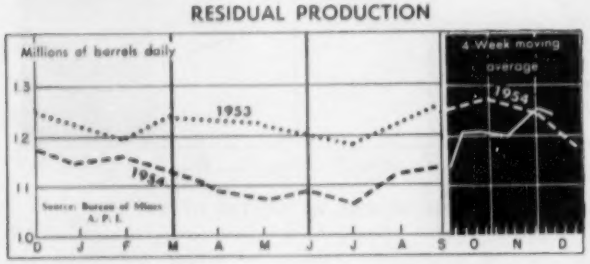
MIDDLE-DISTILLATE PRODUCTION



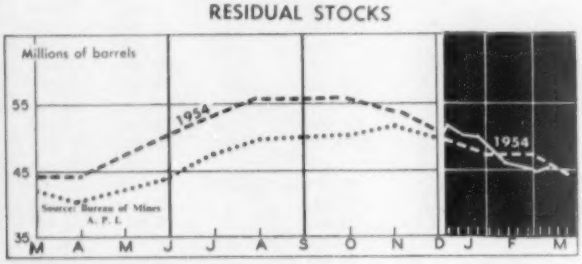
MIDDLE-DISTILLATE STOCKS



RESIDUAL PRODUCTION



RESIDUAL STOCKS



A.P.I. REFINERY REPORT, MARCH 11

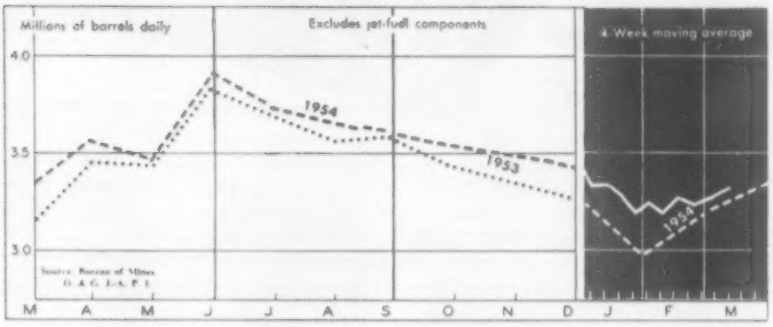
(Excludes all jet-fuel components)

(Thousands of barrels)

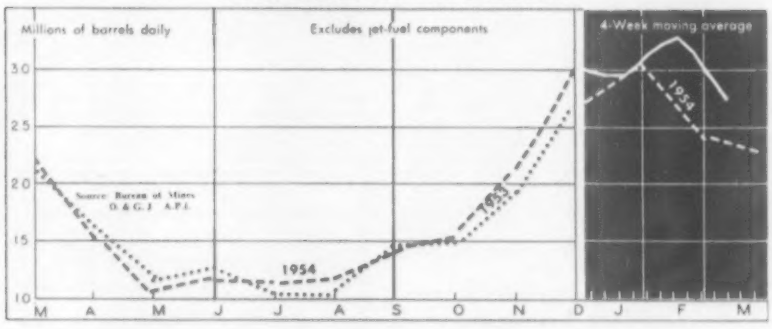
District—	Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.	Stocks‡—Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, March 1954—Daily avg. runs	Daily average production—Gaso.*	Kero.	Dist.	Resid.
East Coast	1,030	415.7	38.3	283.3	236.6	36,646	7,790	22,883	8,358	1,021	410.7	32.1	256.3	212.1
Appalachian:														
District 1	104	35.3	4.0	24.7	8.3	5,049	517	1,580	324	100	41.7	5.3	21.4	12.9
District 2	99	45.0	10.1	20.1	15.6	2,405	263	535	167	94	47.9	6.6	17.2	14.4
Ind., Ill., Ky.	1,393	669.8	77.8	291.0	182.7	41,100	4,535	10,216	2,954	1,274	662.6	73.3	240.3	175.4
Okla., Kans., Mo.	681	382.6	18.3	175.5	41.4	19,441	946	6,648	1,031	582	335.3	16.6	133.4	44.1
Inland Texas	257	166.6	9.4	45.5	19.1	6,644	299	924	1,242	244	167.0	10.5	43.0	27.8
Texas Gulf Coast	1,905	856.7	119.6	551.7	242.9	25,986	1,806	6,419	4,590	1,694	760.7	141.9	383.9	230.8
La. Gulf Coast	640	330.6	69.0	156.1	43.2	12,092	1,101	2,399	1,172	559	246.4	45.7	143.2	45.2
N. La. and Ark.	94	25.7	8.9	22.4	6.7	4,243	643	1,069	146	90	36.8	8.6	21.6	7.0
Rocky Mountain:														
New Mexico	17	9.0	1.0	2.4	2.1	161		81	31	19	12.2	.8	3.2	2.5
Other Rocky Mtn.	250	120.0	4.3	62.0	34.1	8,257	164	1,875	655	234	110.8	3.7	54.2	40.0
California	1,006	457.4	7.7	142.9	386.2	21,400	363	9,203	24,443	1,012	428.9	7.9	140.5	356.3
Mar. 11, 1955	7,476	3,514.4	368.4	1,777.6	1,218.9	183,424	18,427	63,832	45,113	6,923	3,261.0	353.0	1,458.2	1,168.5
Mar. 4, 1955	7,462	3,507.6	347.7	1,826.3	1,180.4	182,343	18,873	65,932	44,298					
Mar. 12, 1954	6,883	3,261.7	378.4	1,428.6	1,194.6	177,783	18,625	64,895	45,973					

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

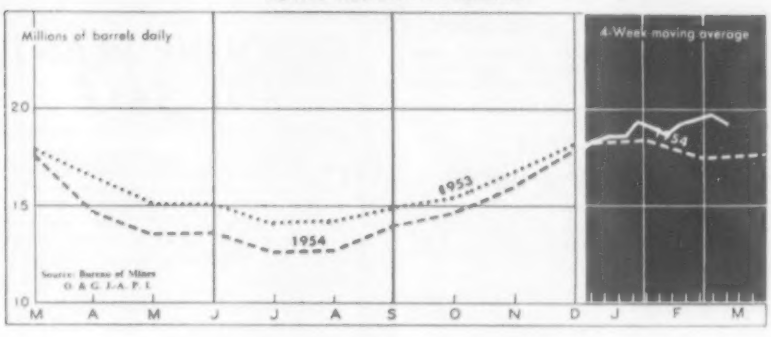
TOTAL GASOLINE DEMAND



TOTAL MIDDLE-DISTILLATE DEMAND



TOTAL RESIDUAL DEMAND



REPRESENTATIVE QUOTATIONS

Spot-market quotations of leading suppliers as of March 16, 1955. Prices are in cents per gallon, except for residual in dollars per barrel and wax in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline	10.25-11	11.25-12	10.50-10.75
Premium gasoline	11.25-12	13-13.75	11.50-11.75
42-44 w.w. kerosine	9.5-9.75	10.6-10.7	9.5-9.75
No. 2 straw fuel oil	8.75-9.0	9.95	9.0-9.25
No. 6 residual	$1.50-1.60	$2.30-2.45	$1.95-2.00

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	4.5	4.0	4.25
Grade 18-55	5.4	4.9	5.15

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	18
200 vis., No. 3 neutral, 0-10 pp.	13.25

WAX

Mid-Continent

132-134 A.M.P.	6.0

• Esso Standard Oil Co. announced increases in tank-wagon prices for gasoline in some of the price-war areas of New Jersey. Socony-Vacuum Oil Co. has raised subnormal gasoline tank-wagon prices in some areas of the New England states. Distillate fuels are freely available on most markets.

PRODUCTION AND DEMAND—MAJOR PRODUCTS

(Thousands of barrels daily)

	Refinery prod.	Total demand
Gasoline:		
Four weeks ended 3-11-55	3,532	3,305
December 1954	3,605	3,455
February 1954	3,365	3,182
March 1954	3,261	3,331
Middle distillate:		
Four weeks ended 3-11-55	2,174	2,732
December 1954	2,049	3,112
February 1954	1,957	2,413
March 1954	1,811	2,235
Residual fuel:		
Four weeks ended 3-11-55	1,237	1,905
December 1954	1,187	1,819
February 1954	1,241	1,742
March 1954	1,169	1,664

CRUDE PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.*	Oklahoma, Kansas	Gulf Coast Tex.†	West Tex.‡
14-14.9	$1.87			
15-15.9	1.93			
16-16.9	1.99			
17-17.9	2.05			
18-18.9	2.11			
19-19.9	2.18			
20-20.9	2.24	$2.50		$2.37
21-21.9	2.30	2.52		2.39
22-22.9	2.37	2.54		2.41
23-23.9	2.45	2.56		2.43
24-24.9	2.53	2.58	$2.91	2.45
25-25.9	2.61	2.60	2.93	2.47
26-26.9	2.69	2.62	2.95	2.49
27-27.9	2.76	2.64	2.97	2.51
28-28.9	2.83	2.66	2.99	2.53
29-29.9	2.91	2.68	3.01	2.55
30-30.9	2.97	2.70	3.03	2.57
31-31.9	3.04	2.72	3.05	2.59
32-32.9	3.12	2.74	3.07	2.61
33-33.9		2.76	3.09	2.63
34-34.9		2.78	3.11	2.65
35-35.9		2.80	3.13	2.67
36-36.9		2.82	3.15	2.69
37-37.9		2.84	3.17	2.71
38-38.9		2.86	3.19	2.73
39-39.9		2.88	3.21	2.75
40 and above		2.90	3.23	2.77

*Standard Oil Co. of California. †Upper Texas Gulf Coast. ‡Sour. Includes New Mexico Permian.

Effective dates: California, February 16, 1953; east of California, June 15, 1953; Pennsylvania Grade, January 21, 1955.

FLAT CRUDE PRICES

Representative posted schedules per barrel

Louisiana:	
Cotton Valley (distillate)	$3.00
Cotton Valley (Holloway crude)	2.95
Texas:	
East Texas	2.90
Chapel Hill	2.83
Conroe	3.13
Van	2.73
Pennsylvania Grade:	
Bradford	3.50
Middle District	3.37
Southwest Pennsylvania	3.08
West Virginia	2.97
Buckeye Grade	2.91
Zanesville Grade	2.72
Illinois Basin	2.90-2.95

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FOR SALE—At Oklahoma City, two Electric Machinery Manufacturing Company belt-driven generators, 44 KVA, 35 KW, 480 volts, price $350.00 each. Cities Service Oil Company, Patridge, Bartlesville, Oklahoma.

CORE DRILLS, SPUDDERS, ROTARIES: New and used equipment. Everything in supplies. Fishing tools rented. Pressey & Son, Pueblo, Colo.

FOR SALE: ENGINE—165 Hp. Climax Model R61, maximum continuous Hp. rating 128. Herndon Drilling Company, 421 Mayo Building, Tulsa. Phone 4-9700.

STAR 45-C CABLE RIG in A-1 condition. 10-in. seamless A-mast; 1300 Caterpillar Diesel engine. 15-in. down to 4-in. Tools. Fully equipped. Rated capacity, 3,000 ft. Also have 5 to 600 ft. of 12-in., 1,000 ft. of 10-in., 1,600 ft. of 8-in. seamless casing. Located near Independence, Kansas. Box H-661, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: 1—Beaird—Ingersoll-Rand packaged Compressor Plant, Type 6-JVG (165 H.P.) Heavy Duty, direct connected, 4-cycle, gas engine driven, single stage equipped with 3—4¼ x 9 compressor cylinders, three hand operated fixed volume pockets, two hand operated valve lifters, 20" O.D. 500# W.P. intake scrubber, air starting equipment and controls for automatic operation. Designed for intake pressure range 100#-250#, discharge pressure range 500#-600#. Delivery 3,480 MCF per day at 250# intake, 550# discharge. This plant has been in use less than 30 days and is located near Palestine, Texas. Box H-616, The Oil and Gas Journal, Tulsa, Oklahoma.

Gaso Duplex 4½" x 6" Power Pumps with Chrysler C-36 Engines, skid mounted, immediate delivery. Also Byron Jackson, Carter Centrifugal Units, Westinghouse 20-25-50 KW Generating Units.

H. H. COFFIELD
Attn.: W. H. ORR
Phones: 132—Rockdale, Texas
AT-3427—Houston, Texas

USED EQUIPMENT

Franks Model 4000-TM Single Drum Well Servicing Units. Single Pole Mast. Truck Mounted.

Franks Model Super East Texas Single Drum Well Servicing Unit. Truck Mounted. Handles 6500' work.

Two Cardwell Models K8 Single Drum Well Servicing Unit. Single Pole Mast. Industrial engine. Mounted on trucks.

50/60 Ideco Skid Servicing Unit. Double Pole Mast. Mounted on International Tandem Truck.

O.C.S. Type 3 Servicing Unit mounted on 1942 Mack Truck. Located Odessa, Texas.

Write, Wire or Call

FRANKS MFG. CORPORATION
BOX 3218, WHITTIER STATION
TULSA, OKLAHOMA

FOR SALE EQUIPMENT

SALES AND RENTALS of Rotary and Cable tools. E. A. Kelly, Okla. City, 3125 S. E. 29th St. Box 861. JA 5-6407.

FAILING 1500 heavy duty drill with 4½x6 pump, automatic pulldown, and mounted on International truck. Write P. O. Box 819, Longmont, Colo. Phone 1333.

FOR SALE: Two R. L. Cardwell Double Drum Spudders with derrick type masts. Would sell complete with Dog House, Light Plant, Wirelines, and Tools or with any part of them. Write Box 871, Seminole, Okla.

FOR SALE at Drumright and Seminole, Oklahoma, 13,000' of 3" and 2,400' of 4" New Asbestos Cement Pipe, Bolted Couplings, 75c and 94c per foot. Deep Rock Oil Corp., Atlas Life Bldg., Tulsa, Okla.

Stop Tong Breakage!
ARMITE DRILL COLLAR
& TOOL JOINT COMPOUND
ARMITE LABS., 6609 Broad St., Los Angeles 1, Calif
Petro. Industries Consultants, C.A. Caracas, Venez.

FOR SALE
CARDWELL SPUDDER

Model KL-175, Double Drum, complete with 5½" and 7" Clean Out Tools, 5200 ft. 3/4" Drilling Line and 5500 ft. 9/16" Sand Line. Used, excellent condition. Priced low for quick sale.

I. A. PARMER WELL SERVICING CO.
Ph. 3-1684 Box 1413
Abilene, Texas

FOR SALE

BOILERS—(8) 304 HP, 125 PSI, Kewanee, Firebox, ASME, complete. (1) 50 HP, 150 PSI, Titusville. (1) 500 HP, Heine, 180 PSI, 2-drum.
COLUMNS—11' x 84' bubble cap, 18 trays, 100 PSI.
9'x42'6" chrome lined, 150 PSI.
6'x37'2" chrome lined, 300 PSI.
35"x44" bubble cap, 18 trays, 18 caps per tray, 300 PSI.
DIESELS—(3) 2160 KW Busch-Sulzer, 3/60/2400/4160 Generators, complete. New 1943.
FURNACE TUBES—100 ton, Like New, 4" OD x ½" wall x 30', 4% chrome.
HEAT EXCHANGERS—1530 sq. ft. Admiralty tubes.
268 sq. ft. Reboiler, steel, welded, 4-pass.
PRESSURE TANKS—(2) 10'x40', 30 PSI.
(2) 7'x45' 13,000 gal. vert., 60 PSI.
(1) 7'x24' 7000 gal. vert., 150 PSI.
(4) 7'x22'6" 6500 gal. vert., 100 PSI.

Heat & Power Co., Inc.
310 Thompson Bldg., Tulsa 3, Okla.—
Phone: 3-4890
70 Pine St., New York 5, N. Y.—
HAnover 2-4890

FOR SALE EQUIPMENT

FORT WORTH SPUDDER Super J-Keystone Model 50 on truck. Excellent condition. Also tools, trucks and pipe. Located in Cherryvale, Kansas. Carl Missimer, Russell, Kansas.

SALES and Rentals of cable drilling and fishing tools, casing and equipment, from the Southwest's largest stock of used cable tools and oil field supplies. Degen Pipe and Supply Co., Tulsa, Oklahoma.

GOOD #1 GRADE USED 8" LINE PIPE FOR LESS!
Save almost ½ the cost of new pipe.
Lapweld 8⅝" O.D. 28.55 used pipe. Straight single random lengths. Machine cleaned. Plain and bevelled or screw end. 850 to 900 PSI. Pipe located in Illinois. Will sell for cash, or will finance meritorious propositions.

REDNEB PIPE CO.
P. O. Box 1798, Shreveport, La., Phone 2-3276.

GASOLINE PLANT *FOR SALE*

Gasoline Plant, located in Brazoria County, Texas, shut down in January, 1954. Had been processing approximately thirty-three million feet of gas daily with absorber pressure approximately six hundred thirty pounds. Plant recovered Propane, Butane, Gasoline, Kerosene and Diesel Oil. Detailed inventory available upon request.

SOUTHERN PRODUCTION CO., INC.
P. O. Box 670, Ft. Worth, Texas

Reconditioned
STEEL PIPE

18,000 feet
8⅝" O.D.—.322" Wall
5,000 feet
10¾" O.D.—.365 Wall
8,000 feet
12¾" O.D.—.375 Wall
2,500 feet
14" O.D.—.375 Wall
Plain Ends—20 ft. R.L.
Ideal for gas, water, oil or structural purposes.
Special low prices.
Immediate shipment.

BROWN-STRAUSS Corporation
1546 GUINOTTE KANSAS CITY, MO.
PHONE HA 1000

FOR SALE EQUIPMENT

N-4 BREWSTER Single Drum Drawworks with one WAK Waukesha Engine—Less than 3 years old—Excellent condition—$11,000.00 —Contact Dick Schriber, Iverson Supply Company, Phone 7-2349, Odessa, Texas.

THREE #12 Sweetland Filters, 48 bronze leaves, monel covered on 3" C.C., now located in southwest, available for inspection. 11 Sperry 18" x 18" cast iron Filter presses, 11 chambers. Consolidated Products Co. Inc. #65 Garden Street, Hoboken, N. J. N. Y. Tel.: BArclay 7-0600.

FOR SALE: Three type 80 Cooper Gas Engine Compressors completely rebuilt. Two type 80 Cooper Compressors as is. One 100 H.P. Superior as is or rebuilt. One Clark 100 H.P. Gas Engine driven Compressor. W. S. Smith, 205 Thompson Bldg., Tulsa, Okla.

FOR SALE—Horizontal Duplex Steam Pumps—10x8½x12—353 GPM—bronze fitted —max. discharge pressure 100 lbs.—6" suction—5" discharge—mfg. by American Marsh Co. Quantity available—NEW—Boston Metals Co. 313 E. Baltimore St., Baltimore 2, Md., Curtis 7-5050.

COMPLETE DRAW WORKS UNIT consisting of Unit 10 draw works and draw works compound including two LeRoi Model E 1500P7 (350 Hp.) draw works power, skid, pump drive and drive sheave. Cimarron Drilling Company, 419 Stanolind Bldg., Tulsa.

FOR SALE—At Oklahoma City a large stock of new Bessemer engine compressor parts at a big reduction. We have just closed down our last plant equipped with Bessemer Type 10 engine compressor units. Complete list and prices. Cities Service Oil, Patridge, Bartlesville, Oklahoma.

FOR SALE

Large quantity 4" used steel line pipe, excellent condition, for immediate delivery by owner.

THE GORDON CO.
1514 Kanawha Blvd. East
Charleston, West Virginia
Telephone No. Dickens 4-1514

JUST PURCHASED!
COMPLETE COMPRESSOR STATION

6 IRKVG-6 gas engine compressor 660 & 600 HP complete with accessories.

$50,000 in new spare parts.

2 IR start. com. model 25C.

25 HP XPF motors.

6—2400 sq. ft. Kellogg Adm. HT.

3—150# drums 10 x 20, 8 x 16, 6 x 20.

6 centrifugal pumps.

200 GPM 90' HD, 60 GPM 460' HD, 400 GPM, 290 HD driven by XPF motors and turbines.

WIRE ! PHONE! WRITE!

Liquidation Levelland, Tex. 6 x 53 CHLIN Tower, MFD 1951.

6'6" x 55', 6' x 27', 5' x 27', 42" x 49', 30" x 35' towers.

1600, (4) 500 Sq. Ft. ADM HT exchangers.

(2) 800 Sq. Ft. (675# 800° F.) St. Exchangers BJ 5-St NICH pump, 400 GPM 2100' hd.

5' x 38' 90# CHR Vessel.

Steel, chrome pipe, valves, fittings, etc.

Available elsewhere 7' x 26' SS, 7'6" x 56' towers.

(4) 424 sq. ft. ADM exchangers.

10—1500, 360, 260 sq. ft. St. Ht. exchangers.

3—RA-8, MA-4 Clark engines.

6—325# Vessels 10' x 35', 7' x 30', 4' x 40'.

Detailed circular upon request.

BRILL EQUIPMENT COMPANY

4101 San Jacinto St., Houston 4, Texas, Locust 1351
New York Office, 2401 Third Ave.,
Telephone Cypress 2-5705

Sell us your surplus equipment

FOR SALE EQUIPMENT

GASOLINE Plant for Sale—operating—6 million foot capacity—located central Oklahoma—recovers natural and mixture. Box H-671, The Oil and Gas Journal, Tulsa, Oklahoma.

80,000 BBL. floating roof API all welded and one 37,000 bbl. wood roof tanks located Brownstown, Illinois, both clean. Bargain for quick sale. W. C. Berry, P. O. Box 1858, Tulsa, Okla.

111 JOINTS 4½" 16.6# weight drill pipe, Spang Shrink Grip. Has drilled 40,000'. Selling account estate. Price $2.10 per foot, stored Tulsa area. No brokers, no commissions. Ray Hose, Hotel Capitol, Springfield, Illinois.

COMPRESSORS FOR INTEREST
in Gas Booster Plant. Will furnish type 80 Cooper Compressors for interest. Must have reasonable reserve. Box H-681, The Oil and Gas Journal, Tulsa, Oklahoma.

GAS COMPRESSORS: One 230 H.P. Clark, one 100 H.P. Superior, five type 80 Coopers, class 'B' Cooper cylinders, 300 lbs. Alfred B. Kern, 227 Wright Building, Tulsa 3, Oklahoma.

EQUIPMENT WANTED

WILL PAY highest prices for used casing, used line pipe, abandoned leases, or other surplus lease equipment. Your idle producing equipment is worth dollars. Green Pipe & Supply Co., Box 1383, Tulsa, Oklahoma.

WANTED—good used pipe suitable for low pressure gas lines. Need approximately 10,000 feet of 20", 18", 16", 10", 8", and 6". Write, wire, or call amount, condition and price to Odessa Natural Gasoline Company, P. O. Box 3908, Odessa, Texas, Phone 6-3241.

HELP WANTED

WANTED: Cable tool drillers on the Bucyrus-Erie Spudder Machine, drilling water wells. Steady work. EGERER-GALLOWAY WELL CORPORATION, 1012 North Third Street, Milwaukee 3, Wisconsin.

EXPERIENCED MAN to take complete charge dismantling Oil Refineries. Knowledge in handling usable and scrap materials. Box H-687, The Oil and Gas Journal, Tulsa, Oklahoma.

IMMEDIATE OPENING for process engineer with experience in operation and design of petroleum refining equipment. Refinery located in southwest. TCC catalytic cracking experience desirable. Write giving resume of experience, availability and salary desired. Box H-628, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS WANTED: By crude oil pipe line operating company for general engineering. Applicants must have recognized degree in civil, electrical, mechanical, chemical, petroleum or industrial engineering. Experience not essential. Salary based on experience and qualifications. Reply to—Employee Relations Department, P. O. Box 1107, Shreveport, Louisiana.

ASSISTANT TO PROCESS SUPERINTENDENT

Man with Chemical Engineering degree or equivalent, to assist Process Superintendent in operation of new independent refinery. Must have several years' operating experience including working knowledge of modern instrumentation and process controls.

Duties will include technical assistance, some operating supervision, scheduling, and coordination of closely integrated units.

Please send complete resume, including salary requirements:

Great Northern Oil Company
P. O. BOX 3396
SAINT PAUL 1, MINNESOTA

HELP WANTED

EXCELLENT OPPORTUNITY for Geologist, under 35, with established independent oil company. Outline experience and personal history. P. O. Box 2775, Dallas, Texas.

BOOKKEEPER-AUDITOR needed by independent oil and gas producer in East Texas. Prefer individual with at least five years experience in oil and gas accounting, including local, state, and federal taxes and royalty accounting procedure. Nice salary. Replies confidential. Box H-680, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEER, Production and Water Flood experience to take complete charge of field operations, Illinois Basin. Give age, experience, and salary expected. All replies confidential. Our employes know of this ad. Box H-669, The Oil and Gas Journal, Tulsa, Oklahoma.

ARE YOU MOVING to Oklahoma City, or want to make a change? Independent oil company with main offices in Oklahoma City has opening for efficient Secretary 35 to 50 years age. Must be expert stenographer with lots of experience in oil production and operations. Must be unencumbered; non-alcoholic and have own transportation. Salary open. Box 1824, Okla. City.

REPRESENTATIVES WANTED

Aggressive geophysical organization with excellent background experience in oil and mining exploration desires Mid-Continent and Gulf Coast sales representation. Forward written qualifications to

Box H-685, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM ENGINEERS

Major oil company has openings for graduate Junior & Senior Petroleum Engineers in its operations in Venezuela. Salary commensurate with experience.

Please send details of exp. to:

P. O. BOX 35
BOWLING GREEN STATION
NEW YORK 4, N. Y.

EQUIPMENT ENGINEER

To review and prepare specifications, standards and inspection procedures for drilling, producing and exploration equipment and supplies. For Equipment Engineering Division located in New York City.

Must have Petroleum or Mechanical Engineering degree together with experience in the manufacture, use and maintenance of drilling and exploration equipment and supplies.

Salary commensurate with education and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 41

ARABIAN AMERICAN OIL COMPANY
505 Park Avenue
New York 22, N. Y.

HELP WANTED

EXPERIENCED LANDMAN, under 35, needed for independent oil producer. State salary required. P. O. Box 2775, Dallas, Texas.

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

SALESMAN OR MANUFACTURERS Representative wanted for Gulf Coast area. Must have oil field experience and sales engineering background would be helpful. Box H-698, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS—For well established manufacturing company. Experienced Engineers for the design and development of Oil Emulsion Treating Equipment, Gas Dehydrators, Stabilizers, Desulphuring Units and other Oil and Gas Well Production Equipment. Must be capable of taking complete charge of project. All information confidential. Reply: Chief Engineer Union Tank and Supply Company, P. O. Box 2092, Houston 1, Texas.

PARTY CHIEF-SEISMOLOGIST AND OBSERVER

Experienced men needed to expand geophysical organization of major oil company. Write, giving personal, educational and experience qualifications and references. All replies confidential.

Box H-664
The Oil and Gas Journal, Tulsa, Okla.

WANTED, MANAGER OF FOREIGN DRILLING OPERATION

Oil well drilling contractor has immediate opening for drilling engineer in Africa. Single status job with liberal salary and bonus.

Drilling & Exploration Company, Inc.
P. O. Box 2—Station "H"
Los Angeles 44, California.

ESTIMATOR

Experienced in process equipment and piping costs for chemical plant and refinery construction. Position offers good future with progressive Penna. firm. Send resume to—

J-65, P. O. BOX 3575
PHILA., 22, PA.

PETROLEUM ENGINEER

for patent liaison work, preferably with field experience. The work involves evaluation of ideas and data, accurately describing and delineating inventions, advising patent attorneys on technical questions, and collaborating with attorneys and inventors in the preparation of patent applications. The position, at a large integrated petroleum research laboratory, affords contact with various aspects of drilling and production. Write

BOX H-686,
THE OIL AND GAS JOURNAL,
TULSA, OKLAHOMA.

PETROLEUM GEOLOGIST

With 8 to 10 years experience in oil field mapping wanted for work on Staff of large producer, with headquarters in Rocky Mountains. Duties will include detailed surface mapping.

Give references, details of education and experience, and salary expected in letter, and include photograph.

Box H-693, The Oil and Gas Journal, Tulsa, Oklahoma.

HELP WANTED

PETROLEUM ENGINEER wanted by independent producing company in Billings, Montana. Must have engineering degree and 3 to 5 years practical experience in drilling and production. Reply should describe education, experience and salary required. Interview will be arranged if qualifications meet requirements. All replies will be kept confidential. Reply to DeKalb Northern Oil Division, 3021 Sixth Ave. North, Billings, Montana.

WATER-FLOOD ENGINEER—by independent oil-producing company. Should have field experience in Mid-Continent area water-flood development and operation. Reply should state qualifications and experience in detail. All applications confidential. Box H-673, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS, Executives, Technical Men Salaried positions—$6,000 to $30,000. This confidential service for outstanding men who desire a change of connection. Will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates 434 Frick Bldg., Pittsburgh 19, Pa.

GEOPHYSICAL SUPERVISOR, foreign experience preferable, by established contract Seismograph Company. Dallas organization. Salary commensurate with experience. Give full qualifications and references. Maximum Age 50. Box H-688, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM GEOLOGIST
Wanted for Staff position in growing independent oil company in West Texas. Must be man of mature age and judgment with at least ten years of practical and successful oil finding experience in exploration and development geology. Should have administrative ability to organize and supervise the work of two or more district geological offices. Salary will be commensurate with experience and abilities. Preferable age limits 35 to 45. In replying please give complete personal and professional background and references. Small recent photo would be helpful. All applications will be treated in utmost confidence, but personal interview will be arranged only if data furnished is adequate and meets our requirements. Box H-691, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED SEISMOGRAPH Party Chiefs and Seismologists by established contract Seismograph Company, Dallas organization. Salary commensurate with experience. Give full qualifications and references. Maximum Age 40. Box H-689, The Oil and Gas Journal, Tulsa, Oklahoma.

SITUATIONS WANTED

PETROLEUM ENGINEER, 34, graduate, eight years engineering and three years production experience with major oil company in West Texas. Desire change to independent in drilling, production or workover operations. Box H-676, The Oil and Gas Journal, Tulsa, Oklahoma.

LANDMAN, 29, 4 years experience, lease buying, title work, farmouts, with major company, desires employment with independent or small company. Box H-677, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST—master's degree, major company experience in Cuba. Surface, subsurface, log interpretation, micropaleontology. Three years in foreign exploration, fluent Spanish. Employed. Desires position in Cuba. Box H-683, The Oil and Gas Journal, Tulsa, Oklahoma.

NAVAL OFFICER (Supply), unmarried, (Annapolis, '50), speaks Portuguese, available June executive position management, major Company. Box 986, Phone 6-3232, Muldrow, Oklahoma.

ALL AROUND MAN available, 20 years experience drilling and production, gas and oil, deep and shallow, high and low pressure wells, workovers. 43 years of age, sober, best of references. Box H-666, The Oil and Gas Journal, Tulsa, Oklahoma.

REFINERY ENGINEER: 7 years experience design, construction and maintenance supervision of fluid and thermofor cat crackers. Also maintenance experience with SO_2 and platforming. Box H-699, The Oil and Gas Journal, Tulsa, Oklahoma.

CHEMICAL ENGINEER, 6 years refinery engineering and operating experience. Includes major catalytic processes. Box H-696, The Oil and Gas Journal, Tulsa, Oklahoma.

ROYALTIES

OFFERING TEN ACRES deeded royalty ahead drilling Gaines County, Texas, excellent deep prospects. Box 1146, Bartlesville, Oklahoma.

PIPELINES ANNOUNCED: Projected pipelines indicate increasing action in central Williston Basin, where we specialize in royalties in major company blocks. For informative material, write LANDOWNERS ROYALTIES COMPANY, Box 1225, Great Falls, Mont.

NEW CUSTOMERS SOLICITED. You can now make very small investments on income Royalties or those ahead of Drilling. A. S. Berry, P. O. Box 1383, Tulsa, Okla.

OFFERING CHOICE PRODUCING oil income royalties with large reserves per Dollar investments. A. S. Berry, P. O. Box 1383, Tulsa, Okla.

JACK EAGLE, Oil Properties, 706 City Nat'l. Bldg., Oklahoma City, Oklahoma, Telephone REgent 6-7027.

LEASE AND DRILLING BLOCKS

FOR LEASE: excellent water-flooding property, surrounded by production. 200 to 1000 acres. Core Analysis indicates from 6,000 to 10,000 barrels of 40° gravity oil recoverable per acre. Depth 1200 feet. Plenty of fresh water available. Box H-678, The Oil and Gas Journal, Tulsa, Oklahoma.

Will pay cash instantly for lease (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

CONTACT A. L. Bowles, Box 947, Ada, Okla., for Drilling Deals, Oil Investments.

DUE TO DEATH in family of interest owner, we are forced to sell two producing and one non-producing leases in Montgomery County, Kansas. Bartlesville sand production. Carl Missimer, Russell, Kansas.

DRILLING Contractor will develop acreage for reliable independent operator for interest in production. Write Box H-662, The Oil and Gas Journal, Tulsa, Oklahoma.

FOR SALE: South ½ of S.E. ¼ of NW ¼ of Sec. 19 Township 5 North Range 9E., Hughes Co., Okla. Consisting of 23½ acres. Two producing wells & fully equipped with two storage tanks and heater. Write Pittsburg Development Corp., Highland, Ill., for further details, or telephone attention of Mr. Hank Weder.

COURT SALE
To settle estate the following lease to be sold to the highest bidder for cash: Undivided 15/64 of 7/8 W.I. (subject to ORR) in producing lease with 4 Permian wells described as SW¼ of Sec. 11-22S-37E, Lea County, New Mexico. Oil and gas income to interest being sold now averaging about $1,000 per month. Sale to be held at court house in Lovington, on March 25, 1955. Address inquiries to Trust Department, First National Bank and Trust Company of Tulsa, Box 2240, Tulsa, Oklahoma.

LEASES ROYALTIES
Producing and Nonproducing
Bought and Sold—Any Area
Inquiries Invited
B. D. BUCKLEY
6635 Delmar Ave., St. Louis, Mo.

NEW PRODUCTS

NEW PRODUCTS for license, outright sale, or franchise. Monthly digest—$1.00. Ten dollars annually. Digest D1, Box 2052, Austin, Texas.

REAL ESTATE

AMBASSADOR HOTEL, Palm Springs, Calif. Property you'd be proud to own, and a tax saver.

LOUISIANA PARADISE — Agriculture — Cattle — Wild Game — 3000 Acres most fertile delta land in south. 3 bales cotton per acre. Cattle, natural year round range. Wild deer, turkey, squirrels and ducks. Thirty - forty thousand dollars merchantable timber. Thirty miles of fence. Good oil possibilities. Not leased. Quick sale, $75.00 per acre. Full description, write—Dr. N. E. Wilson, Homer, La.

WANTED

WANTED—proven production. Independent oil company has cash to invest. Send complete information including engineering. Prefer to deal direct with principals. Box H-675, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Independent or group, with organization of technical and financial resources interested in a foreign operation, Guatemala, Central America. To explore and the possibility to drill for oil. At present can secure some of the best concessions. For further information and plans, write to Dr. Fernando Sarti, 7112 Fir Street, Houston 17, Texas.

WANTED—IDEAS

Inventions that are related or can be adapted to the oil industry. We offer capital, technical advice, patent assistance, market research, a manufacturing plant, and a sales outlet; everything to put your invention on the market. Write P. O. Box 1665, Houston 1, Texas.

NEED FINANCIAL AID for test hole—leased area—Forrest City Basin. Box H-694, The Oil and Gas Journal, Tulsa, Oklahoma.

SETTLED OIL production wanted by independent operator direct from producer. P. O. Box 852, Oklahoma City, Oklahoma.

WESTERN CANADA—Manufacturers Representation—Graduate Mechanical Engineer—desires accounts for sale to oil, gas industries; refineries, pipelines. Excellent contacts. Box H-695, The Oil and Gas Journal, Tulsa, Oklahoma.

BUSINESS OPPORTUNITIES

URANIUM INVESTORS. We are now in a position to offer investors a special service. A Fee of $250. will locate and file a claim for you in Colorado or Utah. We can handle only ten accounts weekly. Therefore for quick service write now for further information and your account number. Uranium Prospectors & Investors Exchange. 516 N. 8th St., Independence, Kansas.

SETTLED PENNA. Grade Oil Production—Company offering to sell So. Ohio properties. Long well life, further development, well-defined area plus immediate satis. yield make offering very attractive. Tax benefits. $40 000 cash required. Principals only. Box H-692, The Oil and Gas Journal, Tulsa, Oklahoma.

SEVERAL HUNDRED validated uranium claims available for sale or farmout proposition to responsible parties. Proven ore bodies, claims with mining in process or exploration properties. Located in Gas Hills area, Fremont County, Wyoming and Colorado Plateau area. Inquiries of substance given prompt attention. Write P. O. Box 626, Casper, Wyoming.

WANT PARTNER to finance drilling well on semi-proven oil and gas block of 745 acres. Will cost $7,700 to drill to 1250 ft. depth to oil sand. Oil is 39 to 41 gravity. Wells have settled production to 40 BOPD. Nets $2.50 per Bbl. These leases have three wells on them; one large gas well shut in. Sand fracturing will bring them in as good producers. These leases are surrounded and adjoined by producing oil and gas pools. Excellent proposition for sure good profits. Long life field. Good geological report. We have equipment. Need finance to drill. Box H-697, The Oil and Gas Journal, Tulsa, Oklahoma.

LEGAL NOTICE

LEGAL

Pursuant to the provisions of Chapter 150 of the General and Special Laws of the State of Texas, passed by the 45th Legislature at its Regular Session, as amended by Senate Bill No. 248, passed by the 53rd Legislature at its Regular Session, the Board of Directors of the Agricultural and Mechanical College of Texas hereby offers for sale at public auction in the Office of the Comptroller, Room 201-D, System Administration Building, College Station, Texas, at 10:00 a. m. Tuesday, April 19, 1955, the oil, gas and sulphur lease on approximately one hundred twenty-seven and sixty-five one hundredths (127.65) acres of land occupied by the Texas Forest Service, located in Newton County, Texas, being out of the Joseph Conn Survey and being the same land as described in a General Warranty Deed from M. Singletary to the State of Texas dated January 3, 1925, recorded in Volume 29, Page 317, of the Deed Records of Newton County, Texas. Only cash bids will be considered. The right is reserved to reject any and all bids. For lease forms and particulars, address Comptroller, Texas Agricultural and Mechanical College System, College Station, Texas.

BUSINESS SERVICE

Delaware Corporations formed and serviced. American Guaranty & Trust Company, P. O. Box 487, Wilmington, Delaware.

PLAT SHEETS

NEW KRAFTBILT PLAT SHEETS will solve your plotting problems. Choose from a broad selection of sizes, scales and paper types. Contrasting lines are sharp and clean. Bond, ledger and tracing papers are top quality. Our line is complete! Ask for Bulletin 155-W. Ross-Martin Co., P. O. Box 800-A, Tulsa 1, Oklahoma.

Exploration

(Continued from page 361)

was 5,117 ft. The well extends production one location to the south and Stanolind has 1,280 acres in the area. Location is Section 36-2s-56w.

WESTERN CANADA

ALBERTA

Stanolind Has Granite Wash Hit in Giroux Lake Area

A Stanolind Oil & Gas Co. wildcat about 150 miles northwest of Edmonton recovered 5,000 ft. of gas-cut oil on a 2½-hour drill-stem test.

The 1 Giroux Lake tested the granite wash from 10,055-75 ft. Following test, operator is coring ahead. The 1 Giroux Lake is 15 miles southeast of nearest production at Little Smoky. Stanolind holds crown reservations on four townships, or slightly under 100,000 acres in the vicinity of 1 Giroux Lake. Location is on LSD 6, 20-65-20w5.

A northwestern Alberta wildcat venture of Stanolind Oil & Gas Co. has discovered light gravity oil in the granite wash formation. The test, 1 Giroux Lake, is 80 miles southeast of Grande Prairie. Late last year the well got some Cardium gas.

Cardium Success Noted at Cynthia Reservation Well

Texaco Exploration Co. and McColl Frontenac Oil Co., Ltd., have indicated

The Westward Ho discovery 55 miles northwest of Calgary made 1,002 bbl. of oil daily on initial potential. The well, a Mississippian strike of major proportions, is just southeast of the Sundre Mississippian discovery, which went on record as the biggest Mississippian hit since Turner Valley.

Cardium oil success at a wildcat on their $13,000,125 Cynthia Reservation.

That venture, located on the eastern side of the tract, has set string of intermediate casing through the Cardium sand, which indicated 12 ft. of pay zone. This well, Texaco 1-27 Aurora, LSD 1, 27-49-10w5, is about 3 miles northwest of Stanolind-Hudson's Bay 1 Pembina "H," and 3½ miles southwest of the 1 "C" Cardium oil discovery well. The crew is deepening the hole towards lower objective.

SASKATCHEWAN

Oil Showing Reported at Carnduff Area Prospect

Imperial Oil, Ltd., and Canadian Superior of California announced details of an oil show that has been found in two drill-stem tests at a well they are drilling in the Carnduff area of southeastern Saskatchewan.

This well, Imperial-Canadian Superior 3-27 Carnduff, LSD 3, 27-2-33w1, tested the Charles zone of the Mississippian formation of intervals at 3,970-85 and 4,004-14 ft. Recoveries on those tests were 90 ft. of oil flecked mud and 120 ft. of Frothy mud-cut oil on the first and 90 ft. slightly oil-cut mud on the second. The well is currently preparing to core at 4,200 ft.

Antler River . . . Another well in this same general area, also being drilled by Imperial, which last week gave up 200 ft. of clean oil from the Mission Canyon sector of the Mississippian has run four more drill-stem tests in that formation. No recovery was evidenced.

This well, 8-34 Antler River, LSD 8, 34-3-3w1, ran the most recent tests at 3,925 and 4,445 ft. Best indicated recovery on those tests was at 3,925-32 ft. The well has been taken to 4,445 ft.,

total depth, and is currently standing cemented with production casing set, after which further evaluation tests will be carried out in the top portion of the Mission Canyon.

Successful Wildcats

TEXAS GULF COAST

Matagorda County: Magnolia Petroleum Co. 1 Savage, I&GN Sur. 8, A-310. IP 218.3 BOPD, 5/32-in., 34.1°, perforations 9,928-31 ft. (New pay in Wadsworth field.)

Jim Wells County: Southwest Workover, Inc., 1 Guadalupe de Perez, La Tinaja de Lara Grant A-36. IP 9,900 M.c.f. daily, open-flow potential, gas-condensate ratio 108,-100 cu. ft. per barrel, 62.1°, perforations 4,809-29 ft. TD 4,875 ft. (New pay in North Alice field.)

TEXAS PANHANDLE

Collingsworth County: Murmanill Corp. 1 Nealey, 13-19, H&GN. IP 1,154 M.c.f. of gas per day, dolomite 1,787-1,810 ft. TD 1,851 ft. (Gas discovery).

WEST CENTRAL TEXAS

Fisher County: Sinclair Oil & Gas Co. 1 McIntyre, 13-22-T&P, 4 mi. N Sweetwater. IP 1,272 BOPD, 32/64-in., TP 340 psi., GOR 640, 41.4°, Canyon pay 5,244 ft. TD 6,620 ft., elev. 2,144 ft.

Shackelford County: Fletcher Oil & Gas Co. 1 Elliott, Sec. 57, BAL Sur., 3 mi. SE Ibex. IP 196 BOPD, 10/64-in., 41°, GOR 720, TP 190 psi., Lake sand 3,848-52 ft. TD 3,894 ft., elev. 1,361 ft.

Stepens County: Warren Petroleum Corp. 1 Boyd, Sara Blythe Sur., A-18, 8 mi. SE Woodson. IP 254 BOPD, 16/64-in., 43°, TP 850 psi., GOR 268, Mississippian lime 4,287 ft. TD 4,296 ft. New pay.

NORTH TEXAS

Clay County: J. C. Man Jr. 1 Phillips, W. W. Yearly Sur., A-745, 2 mi. W Deer Creek. IPP 28 BOPD, 42°, GOR 200, pay 3,338-42 ft. TD 3,342 ft.

Cooke County: J. C. Maxwell 1 Lynch, A. Edmiston Sur., A-353, 3 mi. S Callisburg. IPP 84 BOPD, 34°, GOR 176, Strawn 2,675-77 ft. TD 2,681 ft.

Grayson County: Lone Star Producing Co. 1-A Fallon, J. S. Coffee Sur., A-232, 5 mi. NW Sherman. IP 195 BOPD, ¾-in., TP 40 psi., 32°, GOR 1415, upper Davis 8,691-8,717 ft. IP 343.9 BOPD, ½-in., CP 50 psi., 29.4°, GOR 285, lower Davis 8,848-72 ft. TD 9,133 ft.

Standard Oil Co. of Texas 3 Woodson, Uriah Burns Sur., A-121, 1½ mi. NW Sherman. Well formerly completed as Oil Creek producer. IP 137 BOPD, 16/64-in., TP 125 psi., GOR 450, Davis sand 7,315 ft. TD 10,025 ft., PB 7,650 ft.

Jack County: Kenneth J. Rich 1 Worthington, J. Briscoe Sur., A-1670, 4 mi. N Jacksboro. IP 204 BOPD, ½-in., 41°, TP 225 psi., GOR 1160, conglomerate 5,274 ft. TD 5,438 ft.

Wilbarger County: E. H. Pigg 1-C Pigg-McCrary, 52-14-H&TC, 9½ mi. SE Vernon. IPP 34.6 BOPD, 34.7°, low GOR, Cisco 1,897 ft. TD 2,020 ft.

SOUTHEAST NEW MEXICO

Lea County: T. J. Sivley 1-19 Federal-Sivley, 19-18s-34e. IP 66 BOPD, ¾-in., TP 75 psi., GOR 550, 36°, Queen 4,390 ft. TD 4,445 ft.

SOUTH LOUISIANA

Cameron Parish: Magnolia Petroleum Co. 1-X Ellen Cox, 32-12s-7w. IP 177 BCPD and 1,894 M.c.f. daily, ⅛-in., 47.6°, perforations 13,612-16 ft. TD 13,830 ft. (New field.)

Lafourche Parish: John W. Mecon 1 Jones, 46-17s-21e. IP 205 BOPD, ⅛-in., 33°, perforations 12,232-34 ft., and 303 BOPD, ⅛-in., 38°, perforations 10,936-40 ft. TD 12,800 ft. (Two new pays in La Rosa field.)

St. Charles Parish: The Texas Co. 3 Rathborne, 18-14s-21e. IP 103 BOPD, 7/16-in., 35.2°, perforations 10,300-06 ft. TD 12,500 ft. (New pay in Boutte field.)

St. Mary Parish: Fifteen Oil Co. 7 Veeder-Hunt, 30-13s-10e. IPP 30 BOPD (net), 5 per cent b.s and w., 22°, perforations 2,363-78½ ft. TD 2,464 ft. (New pay in Charenton field.)

Placid Oil Co. 1 Exposito Unit, 105-20s-18e. IP 40 BCPD and 100 M.c.f. daily, 3/32-in., 45°, perforations 13,692-707 ft. TD 13,973 ft. (New pay in Lapeyrouse field.)

OKLAHOMA

Beaver County: Carter Oil Co. 1 State-Ricards, SE NE NW 16-5n-25eCM. IPF 4,445 M.c.f. of gas per day with distillate, Chester 6,993-7,025 ft. TD 7,130 ft. (Geological wildcat discovery).

Cleveland County: Ohio Oil Co. 1 Heims, 7 miles east of Norman, NW SW NE 27-9n-1w. IPF 234 BOPD, second Wilcox sand 6,982-98 ft., 35°, 9/32-in. choke. TD 6,998 ft. (Oil discovery).

Pawnee County: Big Four Petroleum Co. 1 Keeton, 1⅛ miles southwest of Southeast Blackburn field, SW NE SW 30-22n-7e. IPF 120 BOPD, Wilcox sand, open tubing, 42°, 2,889-2,906 ft. TD 2,906 ft. (Oil discovery).

KANSAS

Barber County: Aurora Gasoline Co.-Jones Shelburne & Farmer 1 McKeever, SE SE SE 13-32s-10w. IPP 40 BOPD, Mississippi 4,350-60 ft. TD 4,899 ft. (Opens Sharon pool).

Kingman County: Carter Oil Co.-Cities Service Co. 1 Spade Unit, NW NW NE 27-29s-10w. IPP 6 BOPD, Mississippi 4,312-21 ft. TD 4,800 ft. (Opens Spade pool).

Kiowa County: Gulf Oil Corp. 1 Nichols, NE NE NW 20-29s-18w. IP 7,218 M.c.f. of gas per day, Mississippi 4,995-5,003 ft. TD 5,630 ft. (Gas discovery).

WESTERN NEBRASKA

Banner County, Stauffer: Empire-O'Donnell & Edmondson 1 Stauffer, SW SE SW 15-18n-55w. IPP 300 BOPD, "D" sand discovery, new field. TD 6,191 ft. "J" sand.

CALIFORNIA

Kern County: Exeter Oil Co. 14-J Murphy Fee, SW SW 28-32s-29e, IPF 214 BOPD, 24/64-in. choke, 28° gravity, perfs. 3,961-88 ft., TD 6,089 ft. (New shallow zone discovery in Midway-Sunset field.)

Ventura County: The Texas Co. 1 Berylwood, 16-2n-20w, IPP 60 BOPD, 25 per cent cut, 15° gravity, perfs. 3,625-4,125 ft., TD 4,204 ft. (New field discovery, Calleguas, in Conejo area.)

LEGAL

U. S. DEPARTMENT OF THE INTERIOR. Bureau of Land Management, Santa Fe, New Mexico. Notice is hereby given that approximately 484.79 acres of land in five parcels within the known geologic structures of certain fields in Lea County, New Mexico, will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 2:00 P.M., MST, April 6, 1955, when bids will be opened. Details of the lease offering, how and where to submit bids, may be obtained from the Bureau's Land Office at Santa Fe, New Mexico. J. A. DeLany, Manager.

Equipment Men

Crane Celebrates Century Mark In Fittings Business

A century of achievement is being reviewed and celebrated in 1955 by Crane Co., manufacturer of valves and fittings. Crane Co. had its beginning on July 4, 1855, when Richard Teller Crane, 23, opened a one-man, self-built frame shop in Chicago, a city of 75,000 persons. Then there was no plumbing industry to speak of, very little valve or fitting business and only a primitive heating field.

In the R. T. Crane Brass & Bell Foundry, as the company was originally called, Crane first produced brass couplings and copper tips for lightning rods. Later the company became a manufacturer of valves and fittings, making its own castings. In a few decades it took seriously to the science of metallurgy and became expert in alloying metals.

Today Crane Co. makes thousands of products. A basic list includes valves, fittings, fabricated piping and piping accessories, plumbing fixtures, plumbing brass trip, heating equipment, kitchen cabinets, and accessory equipment for aircraft. Late in 1953, Crane broke ground for a plant in Chattanooga, Tenn., to produce titanium sponge and ingots. The plant will be operated by a subsidiary company, Cramet, Inc., a contraction of Crane metals. Its dedication will be a feature of the company's centennial observance.

Crane now operates plants at: Chicago; Chattanooga; Trenton, N. J.; Maumee, Ohio; Colton, Calif.; Montreal, St. Johns, Port Hope, Calgary and Quebec, Canada; and Ipswich, England.

Bench Moved to Houston By Koppers Co., Inc.

Robert R. Bench has been named sales representative for a new sales office opened in March in Houston, by the Chemical Division of Koppers Co., Inc., according to an announcement by Leo J. Diamond, manager of southern district sales.

The Houston office will be under the supervision of the headquarters office for southern district sales in Atlanta, Ga. Bench, who was formerly a sales-planning engineer, will be responsible for plastics, chemicals, and adhesive sales in Arkansas, Oklahoma, Texas, and Louisiana.

Bench joined Koppers in 1952 as a junior process engineer at the company's Kobuta plant.

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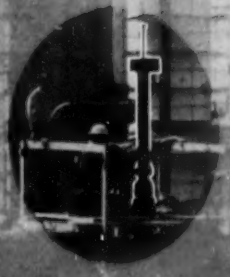

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